Final Report
Port and Modal Elasticity Study

Prepared for

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EXECUTIVE SUMMARY

This study determined the economic viability and impact on demand for San Pedro Bay Port services of assessing additional port user fees to fund the improvements to transportation infrastructure likely required to insure efficient and environmentally sound access to the ports. Today such user fees already exist in the form of fees for the Alameda Corridor rail line. Other major infrastructure improvements may be required to accommodate further traffic growth, and user fees are one possibility for funding such improvements. The Port and Modal Elasticity Study analyses the long-run elasticity of port demands as a function of access fees, determining what levels of fees would induce traffic diversion to other ports or induce shifts in modal shares (truck vs. rail) at the San Pedro Bay (SPB) Ports. These shifts also may depend upon the point in the overall logistics supply chain at which user fees are assessed.

Methodology and Observations:

1. A long-run elasticity model was developed for imports at the SPB Ports. This model allocates imports to ports and modes so as to minimize total inventory and transportation costs from the point of view of importers. Current capacities, contractual obligations and other short-run impediments to shifting traffic among ports and modes are not considered in the long-run model.
2. The long-run model was exercised for two scenarios: As-Is, and Congestion Relief. In the As-Is Scenario, fees are assessed on imports at the SPB Ports without any improvements to access infrastructure. In the Congestion Relief Scenario, average transit time from the SPB Ports to store-door delivery points in the hinterland of the ports is assumed to be reduced by one day, and the standard deviation of this transit time is assumed to be reduced by 0.4 days. The standard deviations of transit times for intermodal rail movements out of Southern California are assumed to be reduced by 0.1 days.
3. A container fee of $192 per forty-foot equivalent unit (FEU) applied to imports over 30 years would be sufficient to retire bonds funding $20 billion in improvements to SPB Ports access infrastructure. Dedicated truck lanes from the SPB Ports to the trans-loading warehouse districts are estimated to cost $16.5 billion. Improvements to main-line rail infrastructure adequate to accommodate 2025 traffic levels at year 2000 transit times are estimated to cost $3.4 billion. Thus a container fee in the range of $190 - $200 per FEU is relevant for the Congestion Relief Scenario.

We conclude that:

1. San Pedro Bay import volume is much more elastic with respect to congestion than with respect to container fees. Import volume is nevertheless elastic with respect to container fees.
2. Without congestion relief, in the long run even a small container fee would drive some traffic away from the San Pedro Ports.
3. A $60 per FEU fee on inbound loaded containers at the SPB Ports would cut both total import volume and total trans-loaded import volume at the SPB Ports by approximately 6%.

4. With congestion relief, San Pedro Bay imports are relatively inelastic up to an import fee value of about $200 per FEU. At this fee level, total imports via the SPB Ports are estimated to decline by 4% or less, while total trans-loaded volume would rise by an estimated 12.5%. The latter suggests a significant increase in economic activity in Southern California.
5. Fees greater than $200 per FEU will significantly diminish imports via the SPB Ports, even if predicated upon congestion relief.

We recommend that:

1. A complete and comprehensive list of effective infrastructure projects be formulated to determine construction cost.
2. The financing cost and term be calculated for these intended investments.
3. Should other (direct) funding be unavailable or inadequate to fully cover cost, that a container fee exclusively used for retiring the bonds for said improvements be uniformly imposed on all imported containers.
4. The practical point of collection is at the dock to be paid by the importer.
5. Further research on this subject be carried out by the consultant. More engagement with importers to confirm or correct model parameters would improve the accuracy of the analysis. It also is desirable to develop a short-run elasticity model, accounting for capacity and congestion at other ports and in various channels.

The Project was financed in part through grants from the United States Department of Transportation – Federal Highway Administration and the Federal Transit Administration – under provisions of the Transportation Equity Act of the 21st Century and additional funding was provided by the California State Department of Transportation.

The analyses and conclusions expressed herein are solely those of the consultant and do not necessarily reflect the views of SCAG, other agencies sponsoring this project, nor any stakeholder in Asian – US maritime trade.

1. OVERVIEW

In February, 2003, the Southern California Association of Governments (SCAG) contracted Leachman and Associates LLC ("L&A LLC") to undertake the first phase of a Port and Modal Elasticity Study ("the Project"). A second phase of this study was contracted in September, 2004, and a third and final phase was contracted in April, 2005. Preliminary reports and findings for each phase of the Project were presented to SCAG and reviewed with critical stakeholders[1]. Authored by Prof. Robert C. Leachman,

[1] A series of working papers were developed in the course of this study. Working Paper #1 reviews and documents previous studies analyzing market competitiveness and elasticities of demand for port services, as well as formulations for infrastructure project funding based on user fees. Working Paper #2 analyzes trade flows to and from the West Coast ports and the competitiveness of the SPB Ports versus other West Coast ports in attracting discretionary traffic. Working Paper #3 develops a matrix of transportation costs by mode, port and inland destination region. Working Paper #4 develops analyses of the inventory costs

Principal of Leachman and Associates LLC, this document reflects the culmination of research, findings, and stakeholder feedback for all Project phases and is its Final Report.

L&A LLC engaged three subject matter specialists as subconsultants to aid in research and to assist in reviewing findings: Theodore Prince, Principal of T. Prince & Associates LLC, (analysis of current trade flows and steamship services; steamship, rail and dray rates; labor and management practices at ports, steamship lines, and third-party logistics vendors), Thomas Brown, Principal of Strategic Decisions LLC, (commercial; labor and management practices at importers, port terminal, rail, dray and intermodal marketing companies), and George R. Fetty, Principal of George R. Fetty & Associates, Inc.,(historical background of the Alameda Corridor, literature research and review; management and labor practices at ports, port terminal, rail and dray companies; feasibility and structure of container fees). The author also benefited from interviews with numerous stakeholders, including importers, third-party logistics companies, port terminal operators, ports, steamship lines, railroads, and dray companies. This input was invaluable.

While a number of studies have been published concerning maritime trade flows and competitiveness of the San Pedro Bay Ports, the findings from the consultant's own research and market share trend analysis for the SPB Ports were utilized herein.
The competitive position of the San Pedro Bay ports remains quite strong, although recently it shows slight erosion to other ports. In 2003 the SPB ports handled 60.4% of all containerized imports (measured on a TEU basis) from Asia to the United States. SPB Ports' share of total inbound containers via West Coast ports (including Vancouver, BC),declined from 72.5% in 2001 to 69.7% in 2004. Shares of total inbound containers grew accordingly at all of the other major West Coast ports (Vancouver, BC, Seattle-Tacoma and Oakland), with Vancouver growing the most.

Containerized trade between Asia and the United States may be categorized into all-water movement to the East and Gulf Coasts via the Panama or Suez Canals and trans-Pacific movements via West Coast ports. Over the period 2001 – 2003, the all-water share of imports grew by 2.4 percentage points per year, rising from 18.6% in 2001 to 21.0% in 2002 and to 23.4% in 2003. While total transportation costs for movement to Eastern US destinations via the all-water channel are much lower than total costs for movement via West Coast ports, continued growth of all-water trade may be inhibited by several factors. First, vessel transits through the Panama Canal are nearing capacity, and bookings on all-water vessel strings via the Panama Canal are increasingly difficult for importers to secure. Second, transit time and distance to East Coast ports via the Suez Canal are longer than via the Panama Canal from all Asian points east of India. Third,

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experienced by US importers of Asian goods. Working Paper #5 discusses intangible factors such as channel capacities and congestion, trends in vessel size, contracts and other forms of inertia, and industry management and labor practices. Working Paper #6 discusses the funding potential of container fees. Working Paper #7 develops the Elasticity Model and documents the computation of elasticities. Working Paper #8 discusses the merits of alternative points for fee application. With the exception of the literature review, the findings in all of these working papers are incorporated into this Final Report, generally corresponding to chapters of the report.

steamship lines are investing in fleets of post-Panamax container ships too large to transit the existing Panama Canal. As these larger vessels enter service, they displace older ships able to transit the Canal, but nevertheless the percentage of total vessel capacity able to transit the Canal is declining. Even if Panama elected to immediately embark on a program of widening the locks to handle post-Panamax vessels, completion of the project would require at least a decade, and a referendum necessary to move forward has been postponed.

Container flows through the SPB Ports also may be categorized as *local* and *discretionary*. "Local" containerized traffic is that which is ultimately consumed (imports) or originally produced (exports) in a geographical area local to the SPB Ports (Southern California, Southern Nevada, Arizona and New Mexico); "discretionary" containerized traffic is that which terminates or originates outside this region. We assume that local traffic must be proportional to the fraction of total continental U.S. purchasing power (personal income per capita times population) that is within the geographical area local to the SPB Ports. Under this assumption, local traffic accounts for only 23% of SPB Ports' total traffic. The other 77% must be discretionary traffic, routed through the SPB Ports for economic reasons. This in turn breaks down into 37% that is short-run discretionary (moving intact in marine containers as inland-point rail intermodal shipments) and 40% that is long-run discretionary (shipments trans-loaded into other vehicles for movement outside the region plus marine containers trucked outside the region).

To explain and ultimately predict the allocation of containerized imports to ports and landside modes, one must analyze the economics of both inventory and transportation from the importers' points of view. The vast majority of imports from Asia are consumer goods imported by US retailers or by the vendors of goods marketed by these retailers. It is thus appropriate to describe inventory and transportation economics for imports in terms of those faced by a retailer of imported goods.

Importers face two basic types of inventory costs sensitive to the choice of port of entry and to the choice of landside transportation mode. One is the cost of pipeline inventory for goods in transit from Asian factories to regional or national distribution centers that serve the importer's retail outlets in the United States. This cost is a linear function of the average transit time of the supply channel, the average declared value of the imports assigned to that channel, and the quantity routed via that channel. The other is the cost of safety stocks maintained at destination distribution centers. These stocks are established as a hedge against uncertainties in transit times and against potential errors in sales forecasts over the lead time from when the goods were ordered. This cost is a complex non-linear function of the variability in lead times and transit times of the shipping channels utilized, the volume assigned to each channel, and the statistical error in sales forecasts. It also is a function of whether shipments are made directly from Asian origin to destination distribution center, or whether shipments to multiple destinations are consolidated from Asian point of origin to a trans-loading warehouse located in the hinterland of the port of entry, then de-consolidated at that point and re-loaded in domestic containers or trailers for landside transport to the multiple destinations. Trans-loading (interchangeably described in this report as consolidation-deconsolidation) pools the variability in forecast errors across the various destination regions and pools the variability in transit time from the factory in Asia to the port of entry across the shipments that are consolidated. When many destinations are consolidated, trans-loading enables a substantial reduction in destination safety stocks. Mathematical formulas to calculate required destination safety stocks for the cases of direct shipping and trans-loading were developed and applied in this study. The required safety stocks are sensitive to the distribution of sales forecast errors. The required safety stocks also are very sensitive to the mean and standard deviation of transit times. Such parameters were estimated by the consultant for various ports of entry, destination cities, and alternative transportation channels.

We found that, for many importers, the cost of their safety stocks is comparable to or even larger than the cost of their pipeline stocks. Moreover, the total cost of their pipeline and safety stock inventories is often larger than the total cost of transporting their goods from Asia to their destination distribution centers.

Both types of inventory costs are linear functions of the value of the goods imported. Differences between inventory costs for direct-shipping and trans-loading options are relatively small for importers of low-value goods but relatively large for importers of high-value goods. For this reason it was important for this study to establish the distribution of values of goods imported from Asia. Data (c. 2003) from the World Trade Atlas (WTA) was furnished to the consultant by the Port of Long Beach. The WTA reports the total value declared to US customs for imports from Asia for 99 commodity types. The Port of Long Beach also furnished the consultant with 2003 PIERS data on TEU volumes imported from Asia by commodity type. The PIERS data for each of the commodity types was joined to the WTA data to establish a distribution of imports by declared value per TEU. This in turn was joined to data from the Pacific Maritime Association concerning the mix of marine container types (20ft, 40ft, 45ft) that are imported and the consultant's estimates concerning the mix of standard and hi-cube 40-foot containers in order to estimate the average declared value per cubic foot for each commodity type. Grouping commodities by similar declared values, an overall distribution of import volume vs. declared value was obtained. This distribution is displayed in Figure S-1. The blue bars are directly derived from the WTA and PIERS data; this raw distribution is much lumpier than reality because a single average declared value has been associated with each commodity type. The red curve represents the consultant's smoothing of the data.[2] This distribution suggests a declared value of about $9 per cubic foot to be the most common one, with steadily declining volumes as the declared value extends up to a maximum of $72 per cubic foot.

Inventory and transportation costs for the top 83 importers of containerized Asian goods were specifically modeled in this study.[3] An average declared value for each of these

[2] As may be seen in the figure, the red curve resembles a Poisson statistical distribution.
[3] In May, 2005, the *Journal of Commerce* published a list of the top 100 importers of goods in ocean-borne containers, derived from PIERS data. 17 of these importers were excluded from this analysis because their imports predominantly come from origins other than Asia.

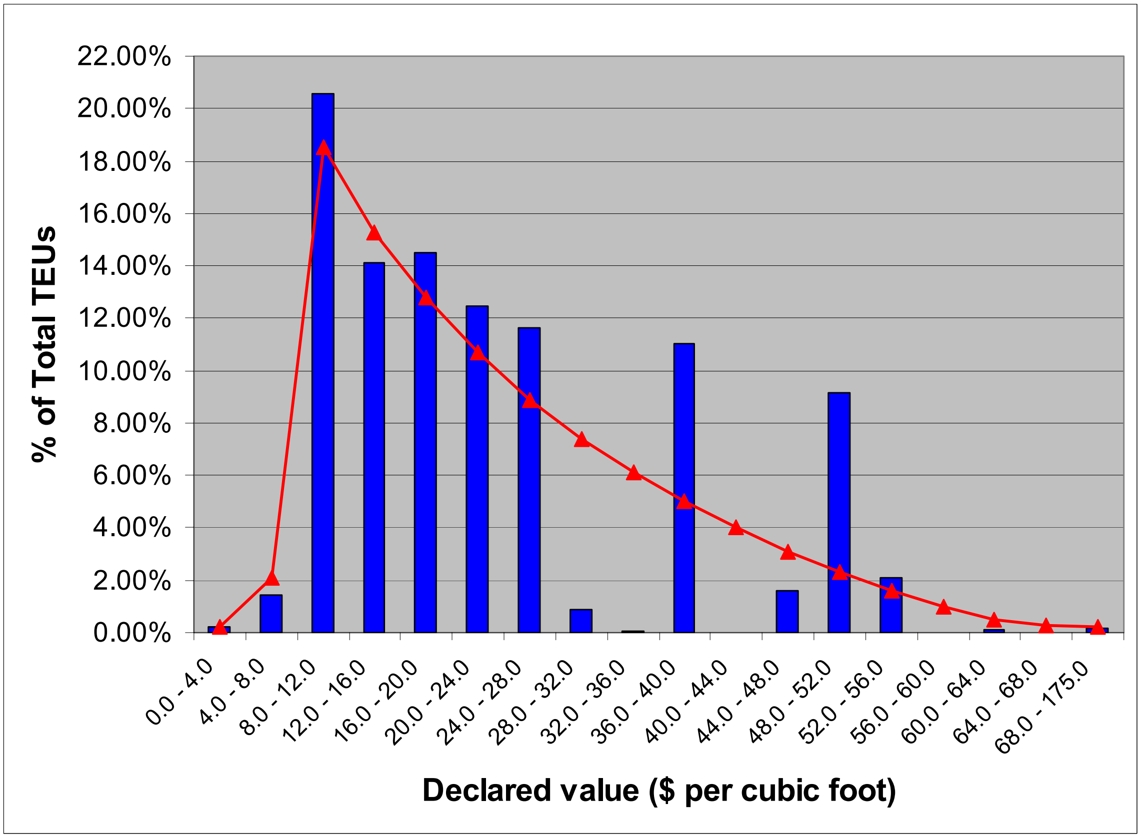

Figure S-1. Distribution of Declared Values for 2003 Asian Imports Through US West Coast Ports

importers was estimated by the consultant based on the types of commodities imported. 2004 PIERS import volumes reported in the Journal of Commerce for these importers were scaled by the consultant to more realistic figures for their imports from Asia.[4] The consultant estimates that these importers accounted for about 32% of total containerized Asian imports to the US in 2004. To account for the other 68% of imports, 19 categories of so-called "proxy miscellaneous" importers were defined at $4 increments in declared value from $2 up to $70 according to the above distribution of declared values. Inventory and transportation costs also were analyzed for these proxy miscellaneous importers. To estimate total nation-wide logistics costs for containerized Asian imports, it was assumed that every modeled importer (i.e., the 83 large importers and the 19 proxy miscellaneous ones) is nation-wide in its distribution of imported goods, with the geographical distribution of its import volume proportional to the distribution of purchasing power across the Continental United States.

Alternative transportation channels available to importers include the following:

[4] Volume statistics derived from PIERS data are low compared to actual volumes. Actual volumes for some importers were found to be as much as 33% higher than PIERS-reported volumes.

- Steamship Line or NVOCC[5] provides inland-point intermodal service. Steamship Line arranges transfer of marine container from vessel to rail and rail line haul movement, all under one rate. Line/Carrier or customer may arrange dray from destination rail ramp to destination distribution center. In this report, we term this the “Direct Rail” channel.

- Steamship Line or NVOCC provides only transportation to port gate with container mounted on a chassis. Customer separately arranges for marine container to be transported from port gate to destination distribution center via long-haul truck or local dray. In this report, we term these the “Direct Truck” and “Direct Local Dray” channels.

- Steamship Line or NVOCC provides transportation to warehouse in the hinterland of the port of entry. Dray from port gate to warehouse may be arranged by Line or by customer. Customer contracts with a third-party logistics firm (sometimes a subsidiary of the Steamship Line or the NVOCC) to provide deconsolidation and trans-loading into domestic trailers or containers. Customer contracts with an intermodal marketing company (IMC) to provide dray from trans-load warehouse to rail ramp in port of entry hinterland, rail line haul and destination dray. In this report, we term this the “Trans-load Rail” channel.

- Same as immediately above as far as the trans-load warehouse. From that point, customer contracts for movement via long-haul truck or local dray to destination distribution center. We term these the “Trans-load Truck” and “Trans-load Local Dray” channels.

For the purposes of this study, 21 destination regions were defined encompassing the Continental United States, and a single destination city was selected within each region. The destination city so selected was one the consultant believes is representative as a locus for regional distribution centers operated by large retail importers. Rates charged by steamship lines, railroads, IMCs, trucking companies and dray companies to these destinations via ten major North American ports of entry (Vancouver, BC, Seattle-Tacoma, Oakland, Los Angeles – Long Beach), Houston, Savannah, Charleston, Norfolk and New York – New Jersey) were researched by the consultant. Many rates are confidential and vary by customer or service provider.. In some cases, an average of a basket of rates was utilized in this study. The data collected for the matrix of 10 ports and 21 destinations by channel was not complete. But enough data was available to infer a structure to the rates, and missing rates were estimated to fit this structure.

In this report, specific rates are not divulged. Only our estimates of the overall transportation charges per cubic foot of capacity are reported for the various channel-port-destination combinations.[6] In general, we find that the total transportation and handling cost for the Trans-load Rail channels ranges \$0.02 less - \$0.05 more per cubic foot of imports than for the Direct Rail channels from the West Coast ports and \$0.07 - \$0.15 more per cubic foot in lanes from East Coast ports. Trans-loading to truck is \$0.40

[5] Non-vessel-operating common carrier.
[6] See Table 18 in Chapter 6.

- $0.60 more per cubic foot than Direct Rail in lanes from West Coast ports and $0.05 - $0.15 more per cubic foot in lanes from East Coast ports.

The trade-off of transportation and inventory costs leads to the result that small importers, importers with few destinations, and importers with low average values of their imports minimize their total inventory and transportation costs by using direct shipping channels. Importers that are nation-wide in scope (i.e., that ship imports to multiple destinations that may be consolidated as far as the port of entry), have moderate or high average values for their imports, and have sufficient overall volume minimize their total transportation and inventory costs by trans-loading their imports in the hinterlands of one or several ports of entry.

We estimate that the largest of the 83 major importers (Wal-Mart) imports an average of 580 TEUs per week to each of the 21 destination regions defined in this study; the smallest ships an average of only 10. The shipping volume for the smallest of the 83 major importers is marginally sufficient for practicing the trans-loading strategy. We therefore assumed all importers in the proxy miscellaneous categories are too small to practice trans-loading, i.e, we assumed all proxy miscellaneous importers solely utilize direct shipping channels.

The transportation cost matrix, the transit time matrix and the formulas computing pipeline and safety stocks were combined into an overall model termed the Long-Run Elasticity Model. For each importer and each alternative strategy for the allocation of imports to ports and channels, this model calculates the total transportation and inventory costs. For each of the 83 major importers and for each of the 19 proxy miscellaneous categories, the model was exercised to compute total costs for the following alternative import strategies:

- Direct shipping of marine containers to destinations using the nearest port and using the least costly landside mode available. (This strategy is attractive to importers of low-valued commodities.)

- Direct shipping of marine containers to destinations using the least costly West Coast port and landside mode combination available. (This strategy is attractive to importers of moderate- and high-valued commodities who are too small or too regional to utilize a trans-loading strategy.)

- Trans-loading of marine containers into domestic containers in the hinterlands of the four ports of Seattle-Tacoma, Los Angeles-Long Beach, Savannah and New York-New Jersey. Destinations are assigned to trans-load centers so as to roughly equalize volumes at each center. The least costly transportation channels from trans-loading centers to destinations are selected. (This strategy is attractive to importers of moderate-valued commodities who are large and nation-wide in scope.)

- Trans-loading of marine containers into domestic containers in the hinterlands of the three ports of Seattle-Tacoma, Los Angeles-Long Beach, and Norfolk. Destinations are assigned to trans-load centers so as to roughly equalize volumes at each center. The least costly transportation channels from trans-loading centers to destinations are selected. (This strategy also is attractive to importers of moderate-valued commodities who are large and nation-wide in scope. Compared to the alternative immediately above, it affords smaller total safety stock but increased transportation costs.)

- Trans-loading of marine containers into domestic containers in the hinterlands of only one or several West Coast ports (Seattle-Tacoma, Oakland, LA-Long Beach). Destinations are assigned to trans-load centers so as to roughly equalize volumes at each center. The least costly transportation channels from trans-loading centers to destinations are selected. (This strategy is attractive to importers of high-valued commodities who are large and nation-wide in scope.)

Total costs were tallied for each alternative strategy for each importer and the best strategy was identified. Then total import volumes passing through the SPB Ports were tallied across importers. This process was repeated assuming the application of a fee on loaded containers imported through the SPB Ports. This fee was assumed to be borne by the importer. Fee values in increments of $30 from $0 to $1200 were tested in runs of the Model. Combining results, an elasticity curve of port demand vs. fee value was constructed.

The Long-Run Elasticity Model was applied to two scenarios: As-Is and Congestion Relief. Both scenarios utilize the 2004 Asia – US import volumes, with each scenario utilizing different assumptions about transit times. Results are summarized as follows.

As-Is Scenario

This scenario includes the consultant's estimates of current statistics on transit times from all ports through all channels. A container fee is assumed to be applied on or near the dock to all loaded containers disembarking at the SPB ports. For a $0 fee, the best distribution strategies as a function of average declared value of imports are summarized in Table S-1.

Table S-1.
Import Strategy as a Function of Declared Value – As-Is Scenario

Importer type	Declared Value Per Cubic Foot	Least-cost import strategy
Large importer	$0 – $13	Direct shipping using nearest port
Large importer	$13 – $27	Trans-load at multiple ports
Large importer	$27 and up	Trans-load only at LA-Long Beach
Small importer	$0 – $46	Direct shipping using nearest port
Small importer	$46 and up	Direct shipping using only West Coast ports

The Model output suggests that a large nation-wide importer of furniture or building materials, such as Home Depot or Lowe's, should opt for direct shipping of their imports. It suggests that a large "big-box" department store importer such as Wal-Mart, K-Mart, or Target should trans-load imports at multiple ports, while an importer of high-value electronics such as Sony or Samsung should trans-load all its imports at only one West Coast port. By and large, these predictions are borne out by actual practice.

As an increasingly larger fee is imposed, the Model predicts that some importers are induced to change strategy. For example, an importer of high-valued goods currently trans-loading only in Southern California would be induced to begin trans-loading at Seattle-Tacoma as well as in Southern California, once the fee is large enough. As the fee is progressively increased, eventually the importer will be induced to discontinue importing through the SPB Ports altogether and truck or use rail to supply its Southern California distribution center from its trans-load warehouse in the hinterland of the Seattle-Tacoma or Oakland ports. The "break points" in fee value for each importer, i.e., where the importer has the economic incentive to change strategy, are calculated using the Long-Run Elasticity Model. At these points the importer's volume through the SPB Ports is predicted by the Model to be reduced.

Figure S-2 displays the resulting elasticity curves for the As-Is Scenario. Shown are curves for total imported containers via the SPB Ports vs. container fee and for total imported containers via the SPB Ports that are trans-loaded vs. container fee. As may be seen, imports at SPB Ports are fairly inelastic until fees in the range of $180 per FEU[7] are introduced. At that point, total volume has declined about 13% and total trans-load volume has declined about 8%. Note that trans-loading traffic is much more inelastic to container fees than is direct shipping. For fees increasing from $180, the analysis predicts steep declines in total container volumes through the SPB Ports. Trans-load volumes hold up much better until fees above $360 are encountered, at which point they too begin steep declines. At $480, the Model predicts that all direct shippers are driven away from the SPB Ports, only trans-loading importers are left.

As a specific reference point, the Lowenthal bill before the State of California Legislature proposes a $30 per TEU (i.e., $60 per FEU) container fee without earmarking funds for any specific program of improvements to port access infrastructure. This study demonstrates just how negative such an approach could be. From Figure S-2 one can see that the Long-Run Elasticity Model predicts a 6.3% drop in imports through the SPB Ports and a 5.9% drop in trans-loaded imports as a result of this fee, provided there are no improvements made to SPB Ports' access infrastructure that would reduce container transit times. Bluntly put, container fees imposed without offsetting reductions in container transit times would have a major negative economic impact on the region and the State.

[7] Forty-foot equivalent unit.

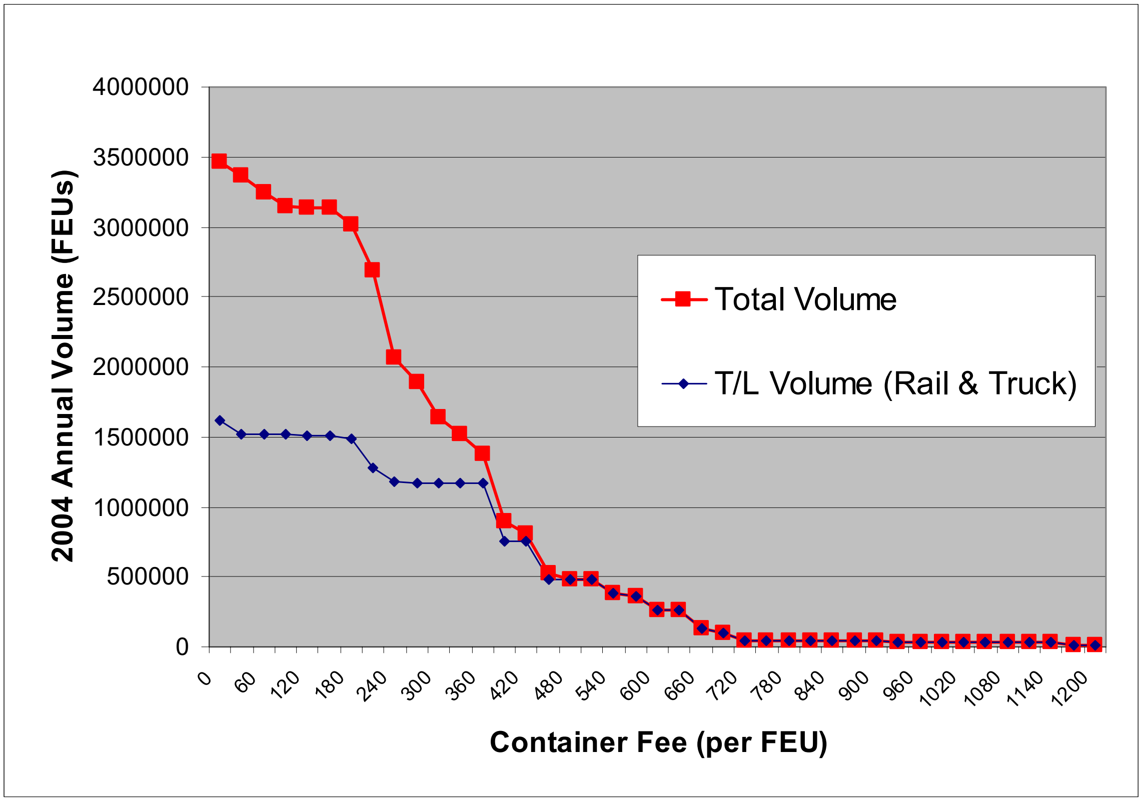

Figure S-2.
Elasticity of Imports via the San Pedro Bay Ports, As-Is Scenario

Congestion Relief Scenario

A different scenario was tested in which transit time statistics were reduced at only the SPB Ports. In particular, the mean transit time from port to trans-loading warehouses was reduced from 3 days to 2 days, and the standard deviation of this transit time was reduced from 2 to 1.6 days. In addition, the standard deviations of rail transit times for movements out of the LA Basin were reduced by 0.1 days, with that for rail movement of marine containers dropping from 3 to 2.9 days and that for rail movement of domestic containers dropping from 1 to 0.9 days. We term this the "Congestion Relief" Scenario.

This scenario represents the case where proceeds from the assessment of container fees are used to retire the bonds on major port access infrastructure improvements, including dedicated truck lanes from the ports to the warehouse district, and rail main-line and terminal improvements permitting more reliable service. The modeled reductions in the mean and standard deviation of port-to-warehouse dray transit times are justified as follows: At present, dray operations for "store-door" traffic typically start on the third day after vessel arrival and complete on the fifth day. (Drays to rail intermodal ramps are completed beforehand.) It is assumed that dedicated truck lanes from the port to the warehouse district would be constructed, enabling double-bottom drays (two containers per dray). This infrastructure would substantially reduce the duration to complete store-door deliveries; the consultant estimates the mean would drop by one day and the standard deviation would drop by 0.4 days. Moreover, a major program of capacity improvements to main lines in Southern California plus the addition of substantial new rail terminal capacity should serve to improve the reliability of rail services. The consultant estimates the reduction in standard deviation of rail transit times from the Los Angeles Basin to Midwestern and Eastern points afforded by such improvements to be 0.1 days.

The Congestion Relief Scenario significantly changes the economics for importers. Assuming no container fee, the break points between import strategies are shifted markedly from the As-Is Scenario. The new break points in value and the corresponding optimal supply-chain strategy were found to be as summarized in Table S-2.[8]

As before, Model calculations were iterated with the addition of a variable container fee assessed on all containers entering through the ports of Los Angeles and Long Beach. The direct and trans-load volumes via LA-Long Beach were then totaled for each fee value in order to construct curves of volume vs. container fee. Results are plotted in Figure S-3. The red curve shows the total inbound container volume through the SPB Ports vs. fee value; the blue curve shows the trans-loaded inbound container volume vs. fee value. For ease of reference, the curves for the As-Is Scenario also are plotted, the yellow curve showing the total inbound container volume and the brown curve showing the trans-loaded inbound volume.

Table S-2.
Import Strategy as a Function of Declared Value – Congestion Relief Scenario

Importer type	Declared Value Per Cubic Foot	Least-cost import strategy
Large importer	\$0 – \$13	Direct shipping using nearest port
Large importer	\$13 – \$17	Trans-load at multiple ports
Large importer	\$17 and up	Trans-load only at LA-Long Beach
Small importer	\$0 – \$46	Direct shipping using nearest port
Small importer	\$46 and up	Direct shipping using only West Coast ports

As may be seen, congestion relief makes the LA – Long Beach ports more attractive to importers. Even for a fee of \$150, total SPB Ports inbound volume is higher than for a \$0 fee in the As-Is Scenario. There is a "knee" in the total inbound volume curve for the fee

[8] While only one of the figures given in Table S-2 differs from the figures in Table S-1 (i.e., \$27 drops to \$17), this change is very significant. As may be seen in Figure S-1, a considerable portion of Asian imports falls into the range of \$17 - \$27 per cubic foot in declared value. These imports are shifted from being candidates for trans-loading at multiple ports to candidates for trans-loading only at the SPB Ports.

equal to $210; at this point, the total volume is only 4.3% below the total volume in the As-Is Scenario with no fee. At this same point, the trans-load volume is 12.5% above the trans-load volume in the As-Is Scenario with no fee. The "knee" in the trans-loaded volume curve occurs for the fee equal to $240; even for a fee as high as $240, the trans-loaded volume is more than 12% greater than the trans-loaded volume in the As-Is Scenario with no fee.

The economic impact of the Congestion Relief Scenario may be summarized as follows. The value of the reductions in transit time and transit time variability are more valuable to large, nationwide importers of moderate-valued and high-valued goods than $200 per FEU, and so total trans-loaded volume at the SPB Ports rises by 12.5%; but importers of low-valued goods and importers too small or too regional to effectively practice trans-loading find it more efficient to divert some of their imports to other ports, and so total import volume through the SPB Ports declines slightly. This structural change in the mix of traffic at the SPB Ports is significant. Direct shipments generate only dray, truck and rail employment within the Basin; trans-loaded shipments generate that employment plus additional dray employment plus deconsolidation center employment plus employment for value-added activities. Trans-loaded imports provide much more for the local economy compared to the imports that simply pass through the Region intact.

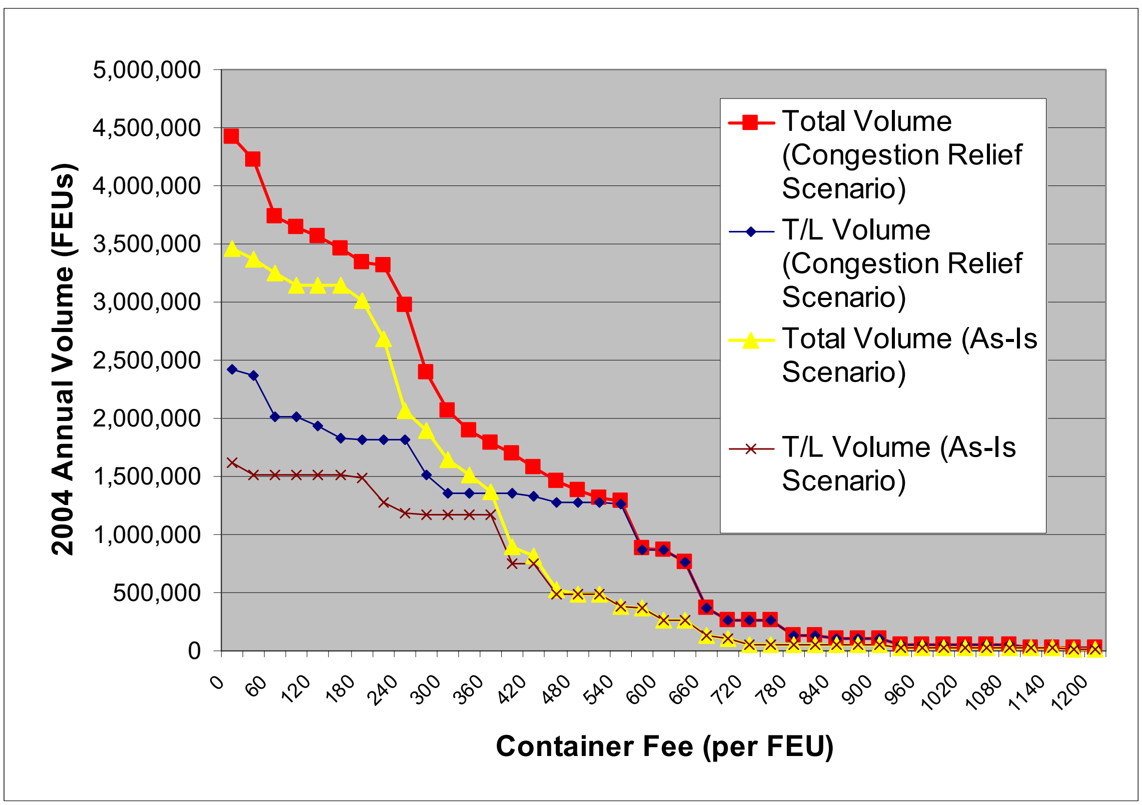

Figure S-3.
Elasticity of Imports at the San Pedro Bay Ports – Congestion Relief Scenario

Assuming a 6% growth rate for imports and assuming a 6% interest rate and 30-year life for tax-exempt bonds financing the congestion relief program, a $96 per TEU container fee ($192 per 40-foot container) assessed on all imported container loads at the SPB Ports would generate sufficient funds for about $20 billion in port access infrastructure improvements. The consultant is advised that dedicated truck lanes between the ports and the transloading warehouse district would cost about $16 billion; and another study completed by the author estimates main-line rail capacity improvements between Los Angeles and Barstow/Indio sufficient to accommodate 2025 traffic levels would cost about $3 billion dollars.[9] This suggests that the Congestion Relief Scenario would be feasible and successful with a container fee (per forty-foot equivalent unit, i.e., per FEU) in the range of $190 - $200.

Excluded Factors

Certain factors are excluded from the Long-Run Elasticity Model; their qualitative impacts are summarized as follows.

Some importers utilize port terminals as virtual warehouses (whereby the importers deliberately delay picking up goods not yet needed at their distribution centers). Others maintain warehouses in the hinterland of the port of entry specifically for this purpose. Economies afforded by these practices are not included in the Model. Qualitatively, these practices extend the economies of trans-loading as the break-point in the average value of imported goods for which trans-loading is more efficient than direct shipping is shifted downwards.

Rail transportation charges input to the Model do not include any surcharges for re-positioning equipment. What matters most in this regard is the relative cost of rail shipment of marine containers vs. cost of rail shipment of domestic containers. If these charges are comparable, the Model's allocations of imports to channels will remain valid. But if re-positioning charges per cubic foot for one of these types of equipment became much larger than for the other, model input parameters would need to be adjusted.

The diversification of port congestion risk is not considered in the model. After the congestion experienced at the SPB Ports in the 2004 peak shipping season, some importers have diversified their use of ports as a hedge against potential congestion. This practice may tend to reduce the SPB Ports volume somewhat below values calculated by the Model.

Short-Run vs. Long-Run: Proper Interpretation of Model Results

[9] *Final Report - Inland Empire Main Line Rail Study*, prepared for the Southern California Association of Governments by Leachman & Associates LLC, June 30, 2005.

In the short run, there are many factors inhibiting the shifting of imports to other ports or alternative channels. There are multiple dimensions of capacity constraining the channel volumes: vessel frequencies and capacities, available transit slots through the Panama Canal, lift capacities at port and rail terminals, available draymen, available trans-loading warehouses, and line-haul capacities of rail and truck channels in the various lanes. Moreover, steamship lines are committed to relatively long-term port contracts whose fee structures provide the incentive for the lines to tender large volumes and mandate stiff penalties for premature withdrawal.

The Long-Run Elasticity Model analyzes transportation and handling rates, values of goods, and transit time statistics faced by importers to determine the least costly allocation of imports to ports and channels. Transit time statistics are exogenously supplied to the model and are not updated if the Model shifts substantial traffic volumes between ports or modes. The Model results should be interpreted as indicating the fee points at which importers would experience an economic incentive to reduce import volumes through the SPB Ports.

Given a scenario in which there is economic incentive to shift imports between modes or between ports, there will be inertia inhibiting such shifts. Major shifts in import traffic may require considerable time to implement. Thus, in the short run, San Pedro Bay Ports traffic will be significantly more inelastic than the predictions of the Long-Run Model. However, given strong economic incentives for importers to shift traffic, one may expect *in the long run* that desired terminal and line haul capacities will get built, new port contracts will be negotiated, vessel strings will be adjusted, new trans-loading warehouses will be erected, and dray forces will be adjusted.

The Long-Run Elasticity Model is intended to inform the public policy dialogue concerning potential major investments in access infrastructure for the San Pedro Bay Ports. Such infrastructure may require up to a decade to build, and financing instruments may require up to three decades to retire the principal. It seems very unwise to rely solely on estimations of short-run elasticity to justify such investments. Investment of large sums of public monies in long-term infrastructure should be confirmed to be sound on the basis of long-run elasticity calculations.

Container Fee Collection

The consultant believes that it is important that any container-based infrastructure fee be assessed against all containers entering the San Pedro Bay Ports regardless of landside mode or destination. The most effective fee collection point is at the dock as an additional wharfage charge. This approach will ensure that all inbound loaded containers are equally assessed a fee and that no transportation mode is exempted. In this way, the competitive place of all transportation providers will remain unaffected by the fee. Moreover, the revenue collected for a given fee value will be maximized. Attempts to collect fees further down the supply chain entail all the risks of missed revenue plus the potential to unintentionally divert shipments from one transportation mode to another.

As proposed herein, the container fee is proposed to be assessed only on loaded inbound containers. Extension of the fee to outbound containers (loaded and empty) is not recommended. The problems with assigning fees to boxes other than inbound loads are twofold. First, for outbound loads, the average value per cubic foot of exports is very low, e.g., corrugated scrap, scrap metal, grain. Transit time is of little importance; transportation cost is the paramount consideration. A significant fee assessed on such exports is likely to cause substantial diversion to other ports of exports originating at inland points and possibly even curtailment of the exports themselves. Second, for outbound empties, a significant additional cost borne at the SPB Ports would encourage the return of containers made empty at inland points to other ports. The resulting imbalance would entail a hardship on the railroads, requiring them to increase re-positioning movements of well cars for hauling double stacks. In all likelihood, the railroads would be impelled to add their own surcharges to the return of containers to other West Coast ports in an effort to correct this imbalance. Low-value exports via other West Coast ports might be curtailed.

The soundest approach to the issue of container fee domain is to restrict the imposition of a fee to imports only. Further, we recommend that per-container charges be used rather than TEU fees. This approach compensates for the fact that all containers, regardless of size, consume infrastructure approximately equally.

Conclusions

San Pedro Bay import volume is much more elastic with respect to congestion than with respect to container fees. Import volume is nevertheless elastic with respect to container fees.

Without congestion relief, in the long run even a small container fee would drive some traffic away from the San Pedro Ports. The Long-Run Elasticity Model predicts that a $60 per FEU fee on inbound loaded containers at the SPB Ports would cut both total import volume and total trans-loaded import volume at the SPB Ports by approximately 6%.

With congestion relief, San Pedro Bay imports are relatively inelastic up to an import fee value of about $200 per FEU. A fee of about $190 per FEU that retires the bonds on a wise and ambitious program of congestion relief seems a safe and effective investment. Total port volume might decrease marginally, but total trans-loaded volume is predicted to increase by more than 12%, resulting in an economically more attractive traffic base.

Fee values greater than $200 per FEU will have serious negative consequences for the SPB Ports and the region, even if predicated upon congestion relief.

Recommendations

We recommend that (1) a complete and comprehensive list of infrastructure projects be formulated to determine construction cost, (2) that the financing cost and term be calculated for these intended investments, (3) should other (direct) funding be unavailable, that a container fee exclusively used for retiring the bonds for said improvements be uniformly imposed on all imported containers, and (4) the practical point of collection is at the dock to be paid by the importer.

We believe that the importer is the appropriate party to pay for several reasons. (1) They are the primary beneficiary of the service. (2) The importers are the drivers of the US economy and are a much more potent political force for obtaining direct funding (thereby reducing the amount of the fee required for a given program of infrastructure improvement or alternatively enabling a greater program of improvement for a given fee amount) from Congress than either the port or maritime sectors, and (3) Market forces would likely result in differentiated pricing over the different port gateways reflecting a more realistic view of operating and asset opportunity costs.

Further Study

Asia – U.S. containerized trade is a highly fragmented enterprise. Data collection for this study was a tremendous challenge. Many important parameters of the analysis had to be estimated by the consultant based on limited information or based on information of limited completeness or accuracy (e.g., PIERS).

The importers themselves are the only ones in possession of accurate values of many of the key parameters of the analysis: actual total transportation and handling charges, actual mean and standard deviation of transit times, actual import volumes by destination, actual declared value of imports, etc. A follow-on effort by the consultant featuring more time engaging with the importers, gaining insight into their practices and gaining access to their data, would be extremely fruitful for improving the accuracy of the analysis.

While the Long-Run Elasticity Model is suitable for informing public policy, a Short-Run Model also is of considerable interest. The impact of changing congestion levels in alternative channels and at alternative ports is exogenous to the Model at present, but it could become part of the model's calculations through the incorporation of formulas developed from queuing theory. The economic impact of contracts between steamship lines and ports also could be incorporated. Time and budget limitations prevented the consultant from developing a Short-Run Model, but it could be done in a follow-on effort.

Finally, the Elasticity Model at present is quite labor-intensive. About a man-day is required per scenario to execute and record Model calculations. The consultant could make this much more automated and much less time-consuming in a follow-on effort.

2. CONTAINER FEES AND OTHER FUNDING SOURCES

Having reviewed a number of data bases, we found no relevant, published economic research in the area of elasticity of demand for port services. The Transportation Research Board, the Foundation for Intermodal Research and Education and the other resources we investigated were unable to identify any work on the topic. Evidently, prior to this study, elasticity of port trade volumes was an unpublished topic. However, there are a number of studies extant concerning the SPB Ports' market competitiveness and the intermodal market share of SPB Ports' container traffic. Eight of these studies were reviewed by the consultant.[10] Chapter 3 provides the consultant's own assessment of the competitive position of the SPB Ports.

The Alameda Corridor is the most prominent example of port access infrastructure employing user fees as a funding source. We therefore explain in detail the user fee structure of the Alameda Corridor. Other instances of user fees for port access are described. However, as noted in the trade press,[11] there is now considerable discussion in the U.S. government of ideas and preliminary proposals for financing intermodal infrastructure improvements. Alternative funding concepts for such improvements now under active discussion by Federal policymakers are reviewed in the next section of this chapter.

Alameda Corridor Fees

The Alameda Corridor Operating Agreement identifies two types of fees paid by the railroads for haulage of port related containers or use of the Corridor (for non-port related cargo). These are termed "User Fees" and "Container Charges".

"User Fees" are triggered whenever a container is loaded/unloaded and transported by rail to/from a port facility or – uses the Alameda Corridor. Therefore, if a container is loaded at a port facility and is transported over a rail line other than the Alameda Corridor the railroad must pay a fee. Conversely, if the container is loaded at a non-port facility, but is transported over the Alameda Corridor, the railroad must pay a fee.

"Container Charges" are applied to all loaded water-borne containers transported by rail to/from a rail ramp in a 10 county Southern California Region, provided the container passes through the San Pedro Bay Ports, but is neither loaded at a port facility nor transported over the Corridor. The counties are San Luis Obispo, Santa Barbara, Ventura, Kern, Los Angeles, Orange, Riverside, San Bernardino, Imperial and San Diego

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[10] See *Port and Modal Elasticity Study, Working Paper #1: Previous Studies on Market Competitiveness, Elasticity of Demand, and User Fee Funding of Infrastructure Improvements,* prepared for the Southern California Association of Governments by Leachman & Associates LLC, June, 2003.
[11] See, for example, *Intermodal Bottleneck Ahead*, Bill Mongelluzo, Journal of Commerce, March 31-April 6, 2003, p. 22-24.

County. This provision was placed in the Alameda Corridor Operating Agreement to discourage draying around the Corridor to avoid the "User Fee". Note that "Container Charges" are applicable to loads only.

When negotiated, the fee was pegged at $15 per loaded TEU (20 foot equivalent unit), and $4 per empty TEU. Non water-borne containers transported over the Corridor are also charged a $4 "User Fee". A small percentage of the Intermodal Container Transfer Facility (ICTF) traffic is non water-borne. The agreement contains a fee escalation clause indexed to the CPI. The escalator is adjusted in January of each year (following the Corridor's opening), and is no less than 1½% or more than 3% in any year. There is no downward adjustment for a deflationary environment. The TEU charge was adjusted for the first time in January of 2003 – the full 3%. Thus, the TEU charge per loaded container during 2003 was $15.45 and an empty TEU was charged $4.12.

When negotiated, carload traffic transported over the Corridor was assessed a "User Fee" of $8 per load, - $8.24 per carload during 2003 because of the January 2003 adjustment. There is no charge for the transport of empty cars. There are exceptions to the general rule. Two of Union Pacific's carload trains are exempted from paying "User Fees". That is because the trains were included in the EIR document, and the ports wanted the trains operated over the Corridor. Neither train hauls port traffic, and Union Pacific agreed to place the trains on the Corridor provided no fee was assessed. Union Pacific had alternative lines over which to operate the trains. Thus, the exception.

The "User Fees" and "Container Charges" will be used to pay off approximately $1.6 billion of debt incurred in construction of the Corridor. The fees run for 35 years or until the debt is retired, whichever comes first. The two San Pedro Bay Ports guarantee up to 40% of the debt service. In the early years of operation, the ports will be required to contribute money for debt service. However, when railroad fees produce a stream of revenue greater than what is needed to service the debt, the ports will be paid back with accumulated interest.

In addition to fees as noted above, the railroads pay for the Corridor's operation, including Maintenance of Way and Dispatching expense. This expense averages another $1.50 per container.

During 2003, about 35% to 37% of the containers passing through the San Pedro Bay Ports were assessed a fee and were hauled by rail to/from the region. The railroads haul an additional number of containers on which no fee is assessed (see discussion of "Container Charges" above). It's estimated that this amounts to an additional 4% of the San Pedro Bay Ports aggregate TEUs.

A study conducted immediately prior to the Alameda Corridor bond offering estimated that the railroad market share would be close to 50% of the total number of TEUs passing through the ports.[12] While perhaps accurate at the time, the percentage in recent years

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[12] *San Pedro Bay Ports Long-Term Cargo Forecast - Final Report*, Mercer Management Consulting, Inc. and Standard & Poor's DRI, October, 1998.

has dropped because of increased transloading, warehousing and distribution of trade with Pacific Rim countries. We are aware of no studies to support the notion that the Alameda Corridor Fees are accelerating this change in goods distribution. Studying this issue is difficult. Tracking container movements is challenging, but once the cargo has left the water-borne container, it is almost impossible to track cargo movement using current data collection resources.

Other Instances of User Fees

A few other instances of container user fees used to finance access infrastructure have come to light. Prior to the Alameda Corridor, the construction of the Intermodal Container Transfer Facility (ICTF) serving the SPB Ports was financed in part by a $30 gate charge collected by a joint powers authority for the purpose. Currently, the Port Authority of New York and New Jersey (PANYNJ) is charging a "cost recovery fee" to the users of Millennium Rail (an on-dock rail facility). The railroads collect the fee and pass it directly to the port authority. The Port of Tacoma charges the railroads a $20 per container fee for containers moving to and from port intermodal facilities. While the fee primarily defrays operational costs (e.g., rail switching of well cars at the terminals), part of its proceeds ostensibly could be used for infrastructure expansion.

Financing Transportation Infrastructure for Port Access

In the years since the initial efforts to develop and fund the Alameda Corridor, a great deal of work has been done to make Federal, State and local policy makers more aware of the importance of freight transportation to national transport policy. The recognition and identification of “intermodal connectors” (which the Alameda Corridor would now be identified as) in TEA-21 and, the proposal that there be set-asides for such intermodal connector improvements in the next iteration of this legislation (“SAFETEA”), represent important steps along this path. Recognition of the often poor condition or inadequate capacity of these connectors has led to an active public dialogue concerning how this issue can most effectively be addressed. At the same time, though, we are still in the “early days” of developing a coherent national transportation policy for freight and in securing adequate funding for the intermodal connector projects that must be undertaken.

In this context, the Alameda Corridor project is considered by policy makers and transport industry figures a pioneering and successful example of how Federal, State and private interests can come together to execute transportation projects which generate large-scale public benefits by leveraging and supplementing privately owned infrastructure with public investment. What SCAG was prescient enough to see in 1983 as a critical regional concern is now recognized as a national one.

Furthermore, with the USDOT’s projection that demand for freight transportation will double by 2020 there is wide spread recognition that existing public and private transportation capacity, even augmented by the currently anticipated levels of transportation infrastructure funding, cannot meet this demand.

Accordingly, there are a variety of approaches to funding freight transportation projects under active discussion. What is most interesting about the variety of these approaches is that few, if any, focus on infrastructure charges on particular modes as a source of funding. Rather, the assumption that drives these approaches is that funding must come from more general revenue sources. We found no examples of U.S. freight projects under active discussion that proposed financing based on an infrastructure charging scheme.

We provide a brief review of the relevant financing concepts below.

1. **Transportation Infrastructure Bank**: Modeled on Freddie Mac or Fannie Mae, this approach would create a national bank that would stimulate low-interest, federally guaranteed loans for freight infrastructure projects.
2. **Issue Federal Bonds** – a variety of approaches have been discussed, two of which are:
    a. **Federal Transportation Bonds *("T-Bonds*"):** Tax-exempt Bonds, underwritten by the U.S. Treasury, would be sold to private investors**,** with the funds used to finance transportation infrastructure projects. Funds generated could be distributed as grants, loans, or credit enhancements.
    b. **Tax Credit Bonds:** Tax credit bonds are proposed as a means of supplementing gas tax revenue in the Highway Transportation Fund and are also anticipated as a means of financing freight connector projects.
3. **Create a Transportation Finance Corporation ("TFC"):** The American Association of State Highway and Transportation Officials' ("ASHTO") solution to solving the infrastructure funding issues across all modes. The TFC would be a cooperative private-government organization that would issue tax-credit bonds (see above) and create a capital-revolving fund to pay for intermodal projects. They propose to issue $60 billion in bonds between 2004 and 2009 to support a $5 billion capital revolving fund.
4. **Increased Priority and Expand Eligibility for Intermodal Projects at the Reauthorization of TEA-21:** The administration bill ("SAFETEA") has taken steps down this path with a 2% set-aside for intermodal connector projects.
5. **Combine and Market Existing Programs:** The U.S. Chamber of Commerce recently identified this as a possible approach: "Components of the program could include: Qualified intermodal investment tax credits, Industrial revenue bonds directed at freight capacity building; Urban Development Action Grants for freight faculties, (and) A waiver of certain property taxes on freight facilities.[13]"

[13] "Trade and Transportation," National Foundation of the U.S. Chamber of Commerce, March, 2003, p. 40.

The conceptual approach and funding for the CREATE (Chicago Regional Environmental and Transportation Efficiency) project in Chicago are considered by many in both the private and public sectors as a model for future freight infrastructure projects. Commercial interests, as well as local, state, and federal officials, have come to agreement on implementing and funding a $1.5 billion rail improvement project for the region; approximately $900 million of which is slated to come from Federal sources, $212 million from the six railroads involved and the remainder from state and local sources. From a rail industry perspective this is considered a model for public-private partnerships wherein the railroads contribute equivalent to the benefits they derive and the public sector contributes relative to the public benefits generated. Of particular interest is the fact that no infrastructure surcharging is proposed; rather this effort seeks to be identified as a "project of National Significance" and to derive the bulk of its public funding from federal sources. Significant support has been demonstrated across the transportation industry (it benefits both passenger and freight) and across the Chicago-region and national political spectrum for CREATE. Some Federal funds were committed in the most recent highway bill but the extent of future federal and state funding remains to be seen.

3. MARITIME TRADE FLOWS

This chapter reviews containerized Asia – U.S.trade flows and trade flows to and from the West Coast ports, analyzing the competitive position of the San Pedro Bay Ports. Terminal facilities and capacities at the West Coast ports are documented, as are current vessel service levels. Overall waterborne container traffic is classified into portions for which port routings can be considered to be discretionary in the short run, discretionary in the long run, and local.

Comparison of West Coast Port Facilities

Container ships operated by transpacific steamship lines predominantly make regularly scheduled calls at the following ten ports on the West Coast of North America, listed north to south: Vancouver, British Columbia; Seattle, Washington; Tacoma, Washington; Portland, Oregon; San Francisco, California; Oakland, California; Los Angeles, California; Long Beach, California; Ensenada, Mexico; Lazaro Cardenas, Mexico; and Manzanillo, Mexico. Our intent in this section is to gain a general idea of the relative capacity and relative level of service at the SPB Ports versus the other West Coast ports.

Container Handling Facilities at West Coast Ports

Table 1 compares the facilities for handling container ships at West Coast ports, as of 2003. Container throughput comparisons are complex because of varying water depths and berth lengths (more depth and length allow larger vessel sizes) and variations in dockside cranes (greater size, speed and number per berth may enable quicker vessel turnaround and higher berth utilization). Considering all of these factors, we estimate that the San Pedro Bay Ports possess at least one third and perhaps as much as one half of the existing West Coast container handling capacity.

Table 1.
Container Handling Facilities at West Coast Ports

Port	Container Ship Berths	Berth Water Depth	Container Cranes
Long Beach	16	9@50ft, 2@48ft, 5@42ft	42
Los Angeles	32	10@53ft, 22@45ft	63
Sub-total, SPB ports	**48**		**105**
San Francisco	4	40ft	7
Oakland	23	5@50ft, 18@42ft	34
Portland	3	40ft	7
Tacoma	7	4@50ft, 3@48ft	18
Seattle	12	9@50ft, 1@45ft, 2@40ft	20
Vancouver, BC	7	5@50ft, 2@40ft	13
Manzanillo, Mexico	2	46ft	4
Ensenada, Mexico	1	36ft	2
Sub-total, non-SPB ports	**59**		**105**

Source: Port web sites

Rail Intermodal Facilities

Rail intermodal terminal capacities for handling double stack trains serving West Coast ports were developed and compared. Table 2 provides an approximate comparison of intermodal handling capacities at the various West Coast ports, as of June, 2003. There are a number of independent variables to be taken into account in this regard (e.g., train lengths vary from terminal to terminal, as do operating hours and container lifting rates on and off double-stack well cars). While some ports report on-dock intermodal facility sizes in terms of numbers of car spots, others report the maximum numbers of trains that can be simultaneously on-spot for loading or unloading. We assumed 25 cars per train for terminals reporting the number of car spots, then rounded off the resulting number of trains. For off-dock terminals, we apportioned capacity based on the current mix of domestic and international traffic handled through the terminal. We estimate that the San Pedro Bay ports possess close to half of the overall West Coast intermodal terminal capacity, as well as close to half of the on-dock or near-dock intermodal capacity.

Transpacific Container Vessel Service

Steamship line service was researched to develop a summary of the distribution of port calls by commercial Asia - North America container vessel strings. A comparison based on services in effect as of May 1, 2003 is provided in Table 3.

Table 2.
Rail Intermodal Facilities at West Coast Ports

Port	Max Number of Stack Trains On Spot at On-Dock or Near-Dock Terminals	Max Number of Stack Trains On Spot at Off-Dock Terminals	Total
Long Beach	9	See Los Angeles	
Los Angeles	9	8	
Subtotal, SPB Ports	**18**	**8**	**26**
San Francisco	1	See Oakland	
Oakland	4	1	
Portland	2	0	
Tacoma	5	See Seattle	
Seattle	4	4	
Vancouver, BC	4	3	
Subtotal, non-SPB Ports	**20**	**8**	**27**

Sources: *POLB/POLA Transportation Study* (June, 2001), Port web sites.
Note: Trains “on spot” refer to those actively loading or unloading. For terminals handling both domestic and international traffic, total capacity has been apportioned based on current domestic and international volumes. Only capacity allocated to international traffic is shown. Train lengths range between 20 and 28 five-well cars. Capacity for car storage not considered.

The table shows the number of vessel strings coming from Asia that make their first North American stop at each port (or port region), the number making their last stop at each port, and the total number of strings serving each port. There are typically 70 vessel strings operated per week between Asia and North America; of those, 4-5 strings per week utilize the Suez Canal route, whereas the rest cross the Pacific. About 21% of the vessel strings make their first U.S. port call on the East Coast, about 18% of the strings call only on the East Coast, 75% of the strings call only on the West Coast, and the other 7% (5 strings) serve both coasts. Most vessel strings serve multiple ports; thus the figures given for the various ports do not add to the total number of strings.

Perhaps the most important statistic derived from this table is that over half (52%) of the Asia-North America vessel strings make their *first* North American port call at the SPB Ports. In contrast, less than 15% of the vessel strings make their *last* North American port call at the SPB Ports. Instead, nearly 62% of all strings make the last North American port call at either Oakland or the Pacific Northwest ports. These figures demonstrate the steamship lines' preference for operating strings that first off-load U.S. imports at the SPB Ports, load up with exports and westbound empties at the SPB Ports, and then top off with more exports and empties at subsequent stops at Oakland and/or the Pacific Northwest ports. Considering all stops, more than 63% of the Asia-U.S. vessel strings serve the SPB Ports.

Table 3.
2003 Weekly Container Vessel Strings, Asia – North America

Port(s)	No. of Strings w/ First Stop = Port(s)	No. of Strings w/ Last Stop = Port(s)	Total Strings Serving Port(s)
East Coast USA via Panama Canal	10	9	14
East Coast USA via Suez Canal	4.5	4.5	4.5
Subtotal, East Coast USA	**14.5**	**13.5**	**18.5**
Long Beach	15.5	3.5	16.5
Los Angeles	21	6.5	27.5
Subtotal, San Pedro Bay	**36.5**	**10**	**44**
Oakland/S.F.	**2**	**23**	**30.5**
Portland	0.5	2	3.5
Tacoma	5	2	8
Seattle	4	8	14
Vancouver, B.C.	6	8	19
Subtotal, PNW	**15.5**	**20**	**24.5**
Manzanillo	1	2	4
Ensenada	0	0	1
Subtotal, Mexico	**1**	**2**	**4**
Total	**69.5**	**69.5**	**69.5**

Sources: Steamship line web sites, ComPair, Pacific Shipper, interviews with steamship line and interviews with ports staff.

Notes: Fractional totals result from inclusion of vessel strings not operated every week. These totals reflect vessel schedules in effect as of May 1, 2003. During peak season (roughly July through October), the number of vessel strings serving the West Coast increases by 3%-7%. Offsetting this increase, some vessel strings serving both West and East Coasts curtail some or all of their West Coast stops during peak season.

San Pedro Bay Ports' Traffic Shares

We begin our analysis of traffic shares by comparing the SPB Ports to the other major West Coast ports for containerized trade. Considering the port capacity and vessel service statistics developed above, one might expect the SPB Ports to handle 50%-60% of the West Coast container traffic. The traffic volumes reviewed below confirm this.

Shares of West Coast Container Traffic

Table 4 displays twenty-foot equivalent unit (TEU) volumes and percentage shares of total container traffic at West Coast ports over the last eleven years. Both loaded and empty container movements – inbound and outbound, both foreign and domestic – at all major West Coast ports are included. Figure 1 depicts the trends in shares of West Coast containerized traffic, comparing the San Pedro Bay (SPB) Ports to the San Francisco Bay (SFB) Ports, to U.S. Pacific Northwest (PNW) Ports (including Portland, Tacoma and Seattle) and to the Ports in the vicinity of Vancouver, BC.

Container movements through the West Coast ports grew at a compound annual growth rate of 6.2% between 1994 and 2002, reaching almost 17 million TEUs in 2002. Container volumes handled through the SPB Ports grew even faster. During the period 1994-2001, the SPB Ports steadily increased their share of West Coast container volumes, rising from about 51% to more than 62%. However, from 2001 to 2004, the SPB ports' share of total TEUs handled has been flat.

Over the period 1994-2002, the traffic shares of the other U.S. West Coast ports consistently declined. SFB Ports dropped from 16% to 10%, and that of the PNW ports dropped from 28% to 19%. Exhibiting an opposite trend, the traffic share of the Port of Vancouver, BC rose from less than 5% to almost 9%, reaching 9.45% in 2004. As with the SPB Ports, the trends in traffic shares over the period 2002-2004 of all other West Coast port regions are flat.

Within San Pedro Bay, Los Angeles overtook Long Beach in 2000, and in 2004 the ratio of LA:LB total container traffic stood at approximately 56:44.

If we examine inbound loaded containers only, a somewhat different picture emerges. Table 5 displays West Coast port shares of inbound loaded containers, 2001 – 2004, and Figure 2 graphs these trends. First note that the SPB Ports' share of inbound containers is higher than their share of outbound containers (both loaded and empty). However, as may be seen, the SPB Ports' share of imports has dropped about 1.8 points since 2001, with Vancouver picking up 1.2 points and the US PNW ports picking up 0.6 points. To more fully comprehend this aspect of the trade flows, it is useful to examine the mix of inbound and outbound containers at the several ports. Figures 3 – 6 display the mix of inbound load, outbound loads and outbound loads at the San Pedro Bay Ports, at Oakland, at the US PNW Ports, and at Vancouver, BC.

Table 4. West Coast Port Volumes, 1994 – 2004
(Total TEUs, loaded and empty, inbound and outbound)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
LONG BEACH	2,573,827	2,843,612	3,067,335	3,504,599	4,097,689	4,408,480	4,600,787	4,462,959	4,526,365	4,658,124	5,779,852
LOS ANGELES	2,518,618	2,555,206	2,682,803	2,959,715	3,378,217	3,828,851	4,879,429	5,183,520	6,105,863	7,178,940	7,321,440
OAKLAND	1,491,002	1,549,886	1,498,202	1,531,187	1,575,406	1,663,756	1,776,922	1,643,585	1,707,827	1,923,104	2,043,122
SAN FRANCISCO	66,486	29,919	5,553	15,973	18,297	39,547	50,147	34,952	25,957	20,633	32,045
PORTLAND	317,961	329,747	302,171	294,930	259,308	293,262	290,943	278,491	255,745	339,571	274,609
SEATTLE	1,414,950	1,479,076	1,473,561	1,475,813	1,543,726	1,490,048	1,488,267	1,315,109	1,438,872	1,486,465	1,775,858
TACOMA	1,027,928	1,092,087	1,073,471	1,158,685	1,156,495	1,271,011	1,376,377	1,320,273	1,470,834	1,738,068	1,797,560
VANCOUVER	493,843	495,463	616,692	724,154	840,098	1,102,092	1,230,020	1,197,142	1,558,786	1,799,881	1,985,042
TOTAL	9,904,615	10,374,996	10,719,788	11,665,056	12,869,236	14,097,047	15,692,892	15,436,031	17,090,249	19,144,786	21,009,528
LONG BEACH	25.99%	27.41%	28.61%	30.04%	31.84%	31.27%	29.32%	29.01%	26.49%	24.33%	27.51%
LOS ANGELES	25.43%	24.63%	25.03%	25.37%	26.25%	27.16%	31.09%	33.69%	35.73%	37.50%	34.85%
OAKLAND	15.05%	14.94%	13.98%	13.13%	12.24%	11.80%	11.32%	10.68%	9.99%	10.05%	9.72%
SAN FRANCISCO	0.67%	0.29%	0.05%	0.14%	0.14%	0.28%	0.32%	0.23%	0.15%	0.11%	0.15%
PORTLAND	3.21%	3.18%	2.82%	2.53%	2.01%	2.08%	1.85%	1.81%	1.50%	1.77%	1.31%
SEATTLE	14.29%	14.26%	13.75%	12.65%	12.00%	10.57%	9.48%	8.55%	8.42%	7.76%	8.45%
TACOMA	10.38%	10.53%	10.01%	9.93%	8.99%	9.02%	8.77%	8.58%	8.61%	9.08%	8.56%
VANCOUVER	4.99%	4.78%	5.75%	6.21%	6.53%	7.82%	7.84%	7.45%	9.12%	9.40%	9.45%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Port web sites. Vancouver volume includes Fraser Surrey Docks, Deltaport, Vanterm and Centerm.

Figure 1. Container Traffic Shares at West Coast Ports

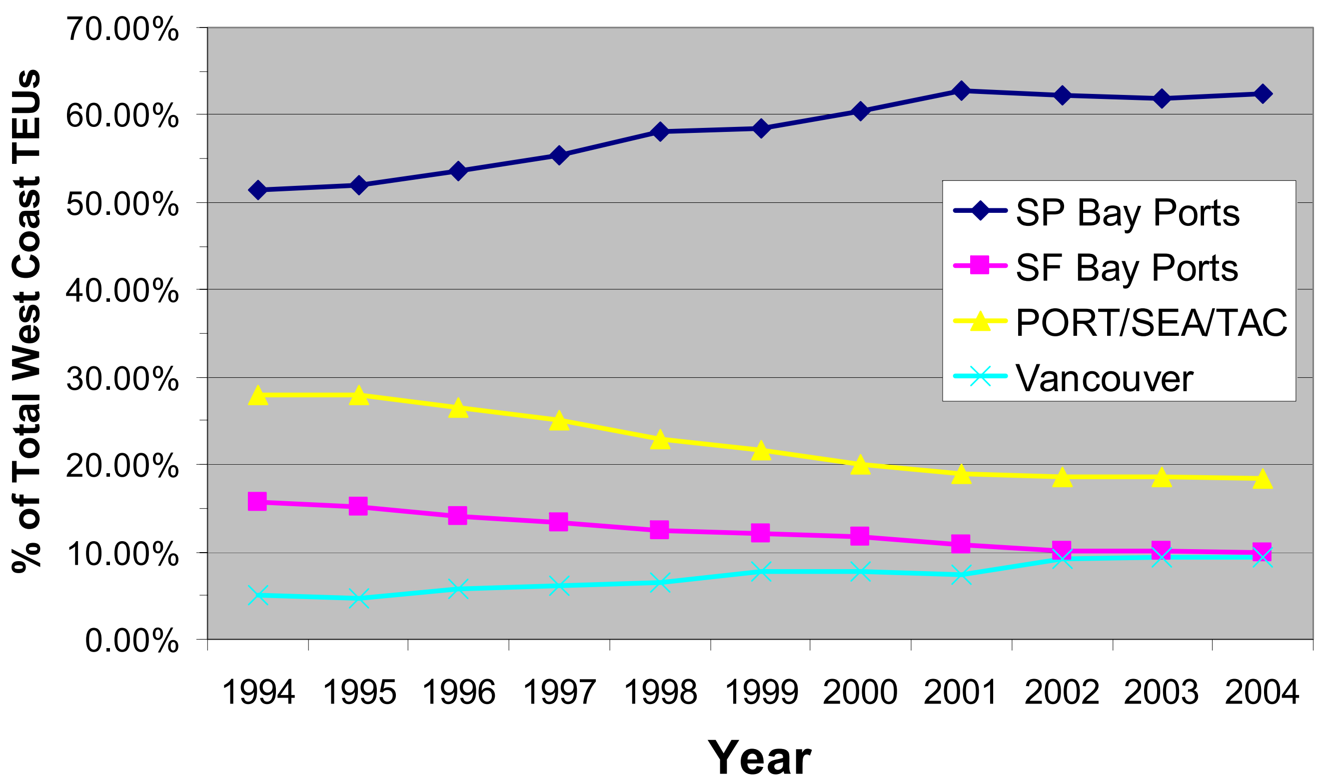


Table 5. Inbound Loaded Containers, West Coast Ports, 2001 – 2004
(Total inbound loaded TEUs)

	1999	2000	2001	2002	2003	2004
LONG BEACH	2,317,050	2,456,188	2,420,687	2,452,490	2,409,557	2,987,980
LOS ANGELES	1,965,853	2,492,546	2,683,657	3,232,411	3,814,473	3,940,420
OAKLAND	469,226	503,858	486,389	547,230	599,408	690,480
PORTLAND	86,900	69,462	63,748	55,447	73,185	71,224
SEATTLE	337,667	416,917	368,069	453,534	555,455	596,582
TACOMA	583,822	594,991	497,068	537,504	542,863	704,664
VANCOUVER	402,791	494,876	520,118	737,324	846,056	947,169
TOTAL	6,163,309	7,028,838	7,039,736	8,015,940	8,840,997	9,938,519
SAN PEDRO BAY	69.49%	70.41%	72.51%	70.92%	70.40%	69.71%
OAKLAND	7.61%	7.17%	6.91%	6.83%	6.78%	6.95%
PNW	16.36%	15.38%	13.19%	13.06%	13.25%	13.81%
VANCOUVER	6.54%	7.04%	7.39%	9.20%	9.57%	9.53%

Source: Port web sites. Vancouver volume includes Fraser Surrey Docks, Deltaport, Vanterm and Centerm.

Figure 2. Shares of Inbound Loaded Containers at West Coast Ports

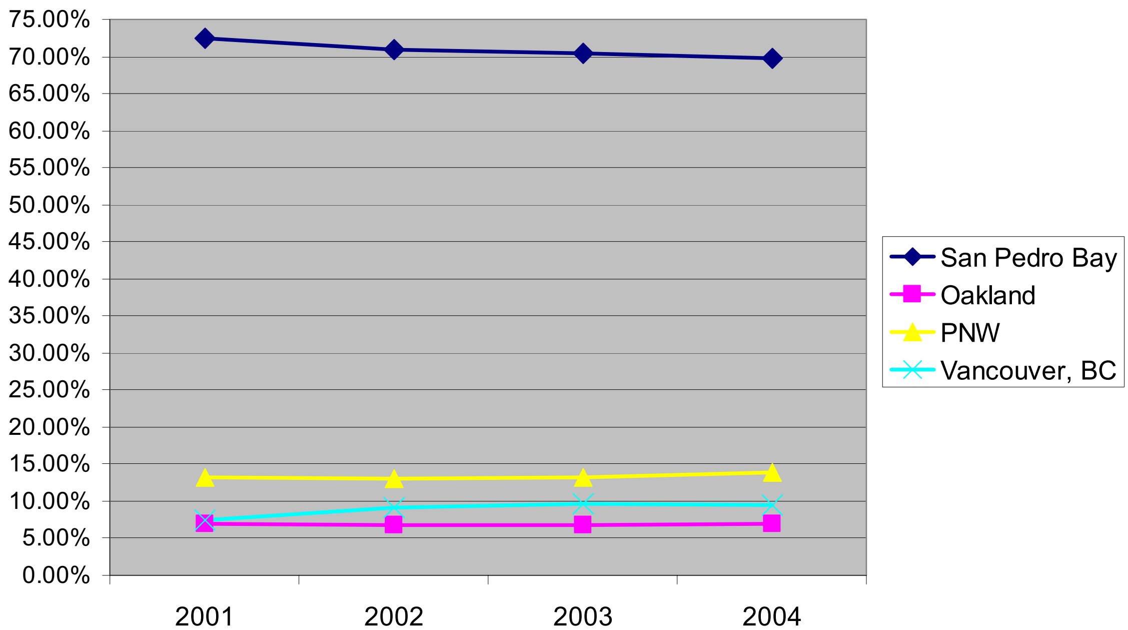


Figure 3. 2004 Distribution of Containers Handled at the San Pedro Bay Ports

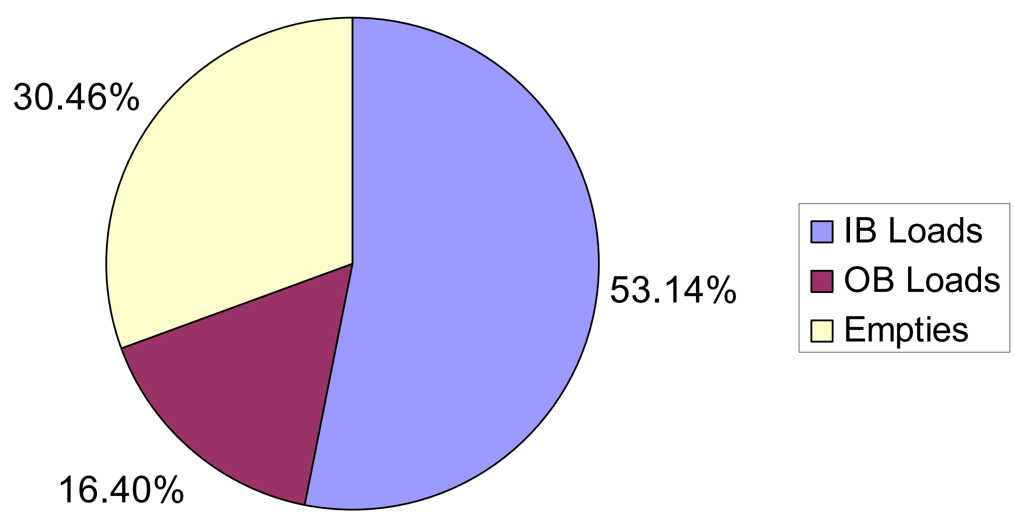


Figure 4. 2004 Distribution of Containers Handled at Oakland

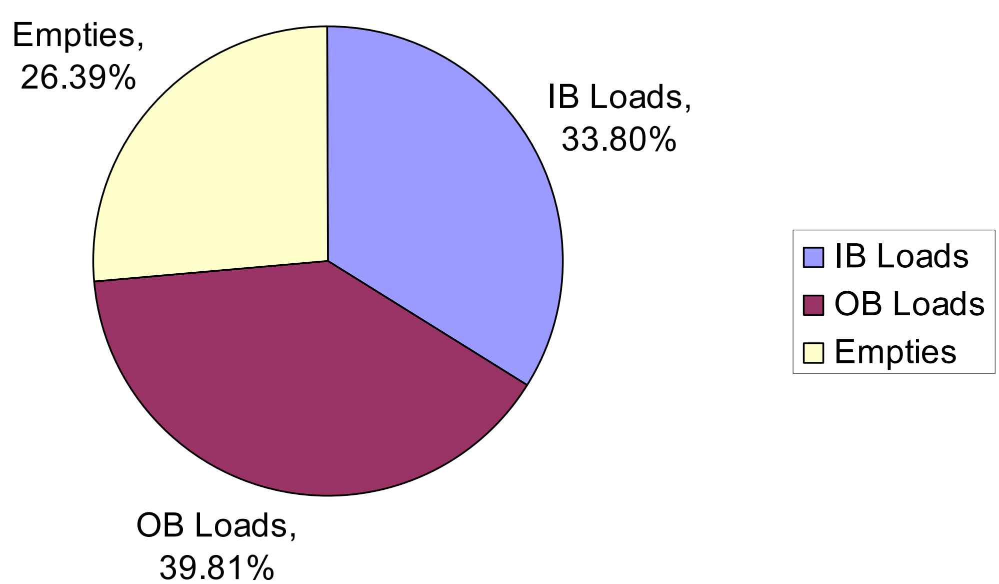


Figure 5. 2004 Distribution of Containers Handled at Seattle-Tacoma

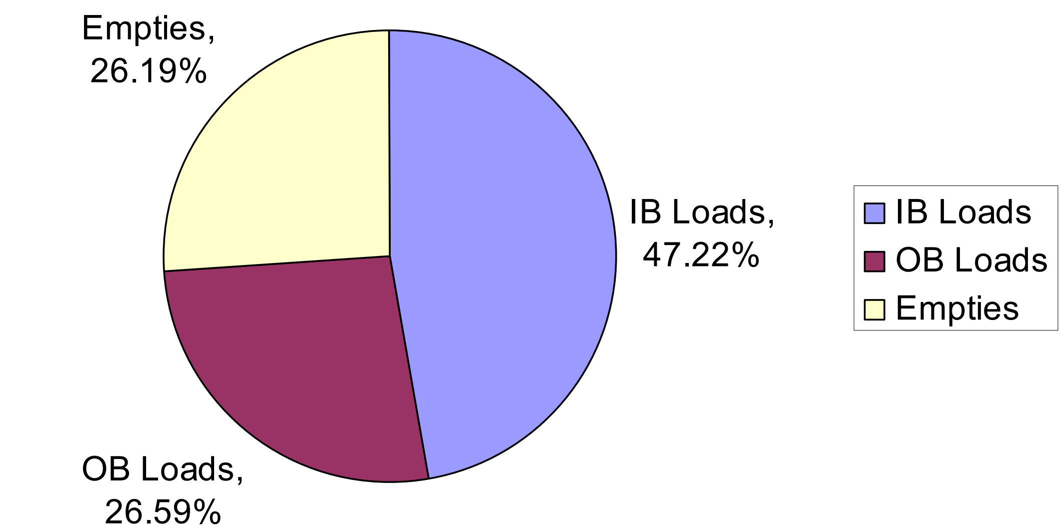
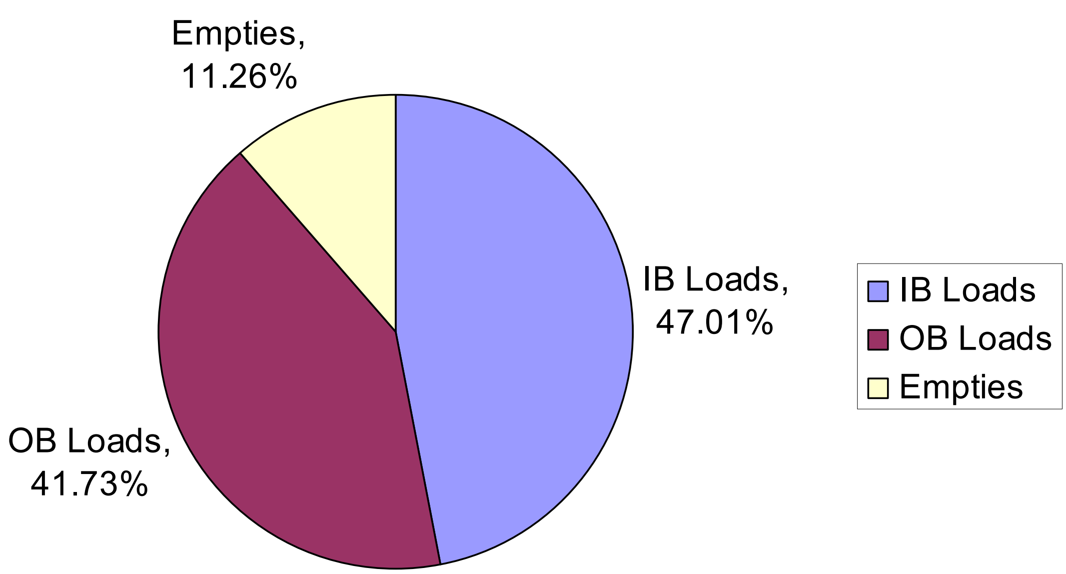


Figure 6. 2004 Distribution of Containers Handled at Vancouver



Inbound empty container volumes are negligible at all ports. As may be seen in the figures, San Pedro Bay is primarily an import port, with about 3.2 inbound containers for every outbound loaded container. Considering both loads and empties, more than 53% of the containers handled are inbound. In contrast, outbound containers outnumber inbound containers at the other West Coast ports. At Oakland, less than 34% of the containers handled are inbound. At the US PNW ports and Vancouver, about 47% of the containers handled are inbound. Thus a significant fraction of the containers that enter North America via San Pedro Bay return to Asia via the other West Coast ports.

Another significant trend concerns the mix of outbound containers. This is documented in Table 6. As may be seen, the fraction of the boxes that are loaded is declining as imports continue to grow. Over the period 2001 – 2004, the total containers handled by the SPB Ports grew by 38%, the inbound loads grew by 41%, and the outbound empties grew by 55%.

Intermodal Share of Imports

The Pacific Maritime Association publishes inbound and outbound container statistics for US West Coast ports. The Intermodal Association of North America (IANA) collects statistics concerning eastbound rail movement of marine containers from US West Coast ports, aggregated into the groups PNW (Washington and Oregon) and PSW (California). By comparing these data, the consultant was able to track trends in the rail share of the movement of inbound marine containers. Statistics on 20-foot, 40-foot and 45-foot containers were aggregated assuming the mix 12.37% 20-foot, 80.28% 40-foot, and 7.35% 45-foot containers and converted into statistics on a TEU basis.[14] Results are depicted in Figure 7.

The fraction of containers moving inland by rail from US West Coast ports is declining. During the period 2000 – 2004, the rail fraction from PNW ports declined from about 82 percent to about 70 percent, and the rail fraction from California ports declined from about 45% to about 40%. Although no IANA numbers are available that are specific to Southern California, one can estimate the fraction of inbound boxes that leave the Los Angeles Basin via rail if it is assumed that the fraction at Oakland is the same as at the PNW ports (70%). For that assumption, the resulting fraction applying to the SPB Ports is 37 percent. As discussed in the previous chapter, the analysis supporting the bonds for the Alameda Corridor indicated the historical percentage at the SPB Ports up until the mid-1990s was 45-50%.

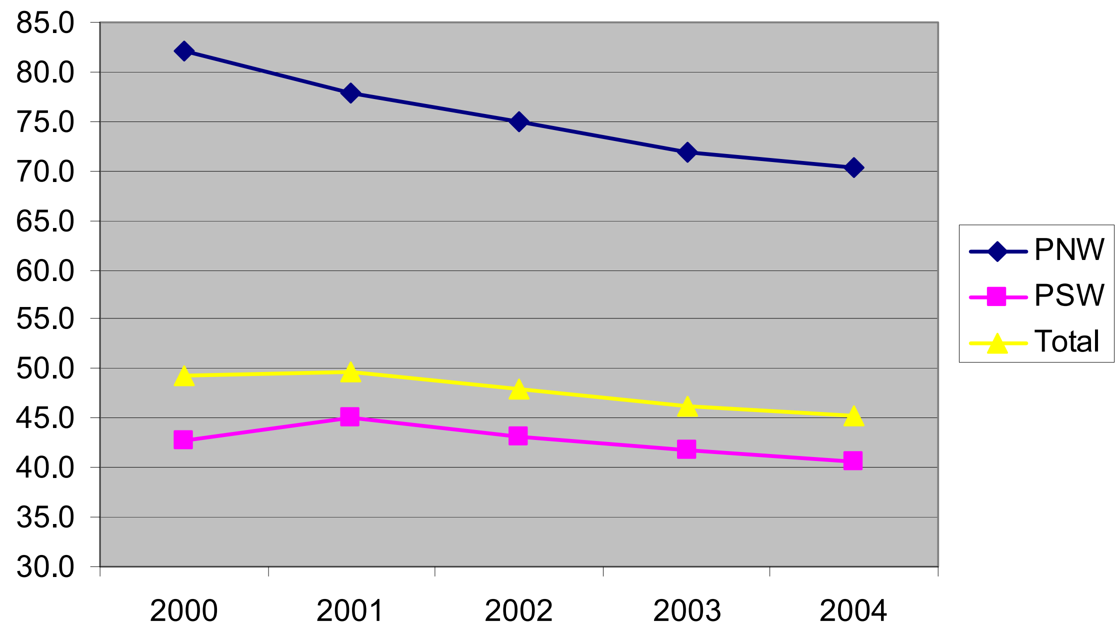
The declines in these percentages do not reflect a decline in the competitiveness of rail vs. truck. Instead, they reflect other factors. One factor is the increase in Asian imports handled "all-water" through East Coast ports (discussed below). The consultant believes the most important factor explaining this decline is the increasing practice on the part of

[14] The assumed mix reflects the statistical average for year 2004 for US West Coast ports, derived from Pacific Maritime Association data.

Table 6.
Mix of Loaded and Empty Containers at the San Pedro Bay Ports, 2001 – 2004
(TEUs)

Year		IB Loads	OB Loads	Empties	Total
	2001	4,908,749	1,990,639	2,551,496	9,450,884
	2002	5,684,901	1,949,709	2,867,360	10,501,970
	2003	6,224,030	2,067,884	3,469,279	11,761,193
	2004	6,928,400	2,137,793	3,971,698	13,037,891
	2001	51.94%	21.06%	27.00%	100.00%
	2002	54.13%	18.57%	27.30%	100.00%
	2003	52.92%	17.58%	29.50%	100.00%
	2004	53.14%	16.40%	30.46%	100.00%
Growth, 2001-2004		41.14%	7.39%	55.66%	37.95%

Figure 7. Percent Intermodal Movement of Inbound Containers



importers to trans-load their Asian imports into domestic containers and trailers at warehouses located in the hinterlands of the ports of entry. The imports are then re-shipped from these warehouses by rail or truck as "domestic" freight. As will be discussed in Chapter 6, there are substantial savings in inventories afforded to large nationwide retailers from this practice. Moreover, the additional transportation and handling expenses of the extra stop to sort and re-ship the imports are moderated by the much larger cubic capacity of the domestic vehicles compared to marine containers. This will be discussed in Chapter 5.

Shares of Asia – U.S. Containerized Trade

The U.S. Maritime Administration (MARAD) provided the consultant with 2003 PIERS data concerning total imports from Asia and exports to Asia by U.S. port. These data are summarized in Table 7. As may be seen, the SPB Ports garnered approximately 60% of total containerized Asian imports via US ports in 2003. The West Coast ports' share was 76.6%; all-water service from Asia to Gulf or Atlantic Coasts captured 23.4%.

Turning to exports, the SPB Ports handled approximately 39.7%. The West Coast ports' share was 70.5%; all-water service to Asia from Gulf or Atlantic Coasts captured 29.5%.

West Coast vs. East Coast Shares of U.S. – Asia Containerized Trade

Published data concerning shares of U.S.-Asia containerized trade routed through West Coast ports vs. East Coast ports is scarce. Statistics presented at the March, 2003 Trans-Pacific Maritime Conference indicate that the all-water share of containerized Asian imports was 21 percent in 2002 vs. only 18.6 percent in 2001.[15] (We remark that this 21% figure precisely matches the percentage of Asia – U.S. vessel strings making their first North American port call at an East Coast port.) Further statistics cited at the Conference reveal that Asian cargo moving through East Coast ports increased 37 percent from 2001 to 2002, compared with 17 percent through the West Coast. As noted above, the all-water share of U.S. – Asia trade rose to 23.4% in 2003, sustaining the growth rate of 2.4 percentage points over another year.

The primary reason cited for this surge in East Coast share of Asia – U.S. trade is the development of high-capacity distribution centers in proximity to East Coast ports by large retailers such as Wal-Mart, Kmart, Best Buy, Home Depot, etc. It was reported that Wal-Mart used West Coast ports for only 43 percent of its Asian traffic in 2001, compared with 74% in 1994.

These centers encouraged the steamship lines to set up additional vessel strings operating through the Panama Canal. (A weekly all-water service to the East Coast requires 8 or 9 vessels, compared with 5 for a transpacific service to the West Coast.) It was reported at the Conference that all-water service from Asia to the East Coast grew at the CAGR of about 9% 1993-1999, about 15% 1999-2001, and about 37% in 2002.

[15] See "East vs. West," *Journal of Commerce*, March 17-23, 2003. The article cites the presentation given by Michael Petracek of Booz Allen Hamilton.

Table 7
2003 Containerized U.S. - Asian Trade by U.S. Port

Port	Imports (TEUs)	Percent	Exports (TEUs)	Percent
Seattle	474,129	5.0	306,123	7.6
Tacoma	587,804	6.2	323,001	8.1
Portland	49,387	0.5	138,565	3.5
Oakland	416,053	4.4	461,412	11.5
Los Angeles	3,489,663	37.1	930,995	23.2
Long Beach	2,199,235	23.4	660,186	16.5
Other West Coast	252	0.0	4,106	0.1
Total West Coast	7,216,592	76.6	2,824,387	70.5
Houston	45,517	0.5	43,363	1.1
New Orleans	5,724	0.1	8,821	0.2
Port Everglades	19,516	0.2	7,380	0.2
Other Gulf Coast	207	0.0	16,011	0.4
Miami	109,039	1.2	22,011	0.5
Jacksonville	5,004	0.1	1,439	0.0
Savannah	491,258	5.2	332,959	8.3
Charleston	247,215	2.6	133,543	3.3
Wilmington	43,270	0.5	25,967	0.6
Norfolk	288,408	3.1	183,088	4.6
Baltimore	49,225	0.5	38,442	1.0
Philadelphia	48,435	0.5	4,628	0.1
NY – NJ	826,926	8.8	347,474	8.7
Boston	19,142	0.2	17,472	0.4
Other East Coast	233	0.0	964	0.0
Total GC+EC	2,199,371	23.4	1,183,562	29.5
Grand Total	9,415,643	100.0	4,007,950	100.0

Source: PIERS, courtesy of MARAD.

Note: Totals exclude Hawaii, Alaska, Puerto Rico and Asia – U.S. trade handled via Canadian or Mexican ports. Norfolk figures include Newport News. Philadephia figures include Chester, PA.

Savannah has been perhaps the most successful East Coast port in competition for Asian business. Savannah's containerized shipments from Asia jumped 41 percent in 2002 to 666,000 TEUs. Charleston, Norfolk and New York-New Jersey also saw steep increases.

Looking to the future, continued growth of all-water trade may be retarded or inhibited by several factors. First, vessel transits through the Panama Canal are nearing capacity, and bookings on all-water vessel strings via the Panama Canal are increasingly difficult for importers to secure. Second, transit time and distance to East Coast ports via the Suez Canal are longer than via the Panama Canal from all Asian points east of India. Third, steamship lines are investing in fleets of post-Panamax container ships too large to transit the existing Panama Canal. As these large vessels enter service, they displace older ones able to transit the Canal, but nevertheless the percentage of total vessel capacity able to transit the Canal is declining. Even if Panama elected to immediately embark on a program of widening the locks to handle post-Panamax vessels, completion of the project would require at least a decade, and a referendum necessary to move forward has been postponed.

Traffic Shares by Inland Region

The Journal of Commerce PIERS database is a summarization of US customs data concerning containerized imports. Tabulations are available by port, commodity code, shipper, destination and quantity of containerized imports. Unfortunately, many types of aggregate statistics derived from PIERS are unreliable. MARAD advised the consultant that only about 20% of the import records have correctly filled out destination records, and it cautioned against using the PIERS data as a base for analyzing the geographical distribution of imports.

The Port of Long Beach supplied the consultant with PIERS data for the West Coast ports for the years 2001-2003. These data frustrated any determination of the geographical distribution of destinations.[16]

The statistics cited in Table 8 below concerning inland shares of West Coast container traffic date from 1996.[17] These data also were developed from the PIERS database, considering only loaded containers routed through the major U.S. West Coast ports. North American destinations were grouped into ten regions defined as follows:

CA/NV
AZ/NM
South: TX, OK, AR, LA, AL, TN, MS, GA, FL, SC, NC
Upper Midwest: ND, SD, MN
Canada
Mexico
PNW: WA, OR, ID, MT
Mid Rockies: UT/WY/CO
Neutral East: NE, KS, IA, MO, IL, WI, IN, MI, OH, KY, WV, VA, PA, MD, DE, NJ, NY, CT, MA, VT, NH, ME, DC
AK/HI

The rationale for grouping the states this way was as follows. Compared to other West Coast ports, the PNW ports offer landside cost and transit time advantages for serving the PNW and Upper MW regions. The CA/NV region is best served by either the SPB Ports or the SFB Ports. The Mid Rockies region is also competitively served by the SFB and SPB Ports, but there is more potential for traffic to be routed through the PNW ports than in the case of the CA/NV region. Assuming stack trains are routed through Memphis or New Orleans gateways, the SPB Ports can offer landside cost and transit time advantages for serving the South. None of the West Coast ports would seem to offer a substantial

[16] For example, the most common destination shown for imports through the Port of Los Angeles was "Unknown". Next was California, and third most common was "Puerto Rico"(!).
[17] The data in Table 8 is adapted from *San Pedro Bay Ports Long-Term Cargo Forecast – Final Report*, Mercer Management Consulting, Inc. and Standard & Poor's DRI, October, 1998.

advantage serving the states in the Neutral East region, as distances and rail rates from all West Coast ports are comparable. (We shall take up the economics of the alternative West Coast ports in subsequent chapters of the report.) Generally speaking, rail intermodal haulage accounts for the lion's share of traffic to/from the Upper MW, Neutral East and South regions, while truck haulage dominates the CA/NV, AZ/NM, PNW and Mid Rockies regions.

Table 8 displays total 1996 TEU volumes and shares by region for the U.S. West Coast ports, grouped as SPB Ports (Long Beach and Los Angeles), SFB Ports (Oakland and San Francisco) and PNW Ports (Seattle and Tacoma). The SPB Ports dominated traffic to/from the CA/NV, AZ/NM, South and Mexico regions, as might be expected considering their cost and time advantages. But they also pulled in 63% of the Neutral East traffic, 47% of the Upper MW traffic, 48% of the Mid Rockies traffic, even 21% of the Canada traffic. The substantial shares of these latter regions are not explained by landside cost or time advantages; instead they must be the result of the preference of steamship carriers to call at the SPB ports first and off-load discretionary containers at the first port of call.

Table 8
1996 Total Containerized Cargo Shares - U.S. West Coast Ports

	Via SPB		Via SFB		Via PNW		Total
	TEUs	**Percent**	**TEUs**	**Percent**	**TEUs**	**Percent**	**TEUs**
CA/NV	1,524,528	69%	453,615	21%	230,470	10%	2,208,613
PNW	73,620	13%	32,334	6%	470,843	82%	576,797
AZ/NM	21,070	84%	3,135	12%	903	4%	25,108
Mid Rockies	20,042	48%	15,512	37%	5,931	14%	41,485
Upper MW	21,442	47%	3,126	7%	21,492	47%	46,060
Neutral East	900,012	63%	118,817	8%	413,883	29%	1,432,712
South	532,273	79%	49,302	7%	88,724	13%	670,299
AK/HI	36	2%	26	2%	1,643	96%	1,705
US Total	3,093,023	62%	675,867	14%	1,233,889	25%	5,002,779
Canada	34,995	21%	7,160	4%	121,437	74%	163,592
Mexico	33,469	99%	181	1%	33	0%	33,683
Unknown	376,943	71%	38,776	7%	112,094	21%	527,813
Total	3,538,430	62%	721,984	13%	1,467,453	26%	5,727,867

Source: *San Pedro Bay Long-Term Cargo Forecast*, Mercer Management, Inc. and Standard and Poor's DRI, October, 1998. Based on PIERS data.

Discretionary Traffic

Previous consulting studies for the SPB Ports identify the container traffic to/from the predominantly intermodal-served regions Upper MW, Neutral East and South as the "discretionary" traffic passing through West Coast ports. Containers to/from the PNW, CA/NV, AZ/NM and Mid Rockies regions are termed "local" traffic.[18]

Steamship lines sell transportation from Asia to inland U.S. points such as Chicago under a single rate regardless of which port the container is routed through. While the shipper typically chooses the vessel string, the choice of port at which to off-load the cargo belongs to the steamship line, so the port routing seems mostly discretionary in that case. However, as will be discussed below, steamship lines enter into long-term lease contracts with ports that feature incentive pricing based on volume. Thus even if a steamship line finds an inland economic incentive to shift traffic from one port to another, the terms of the port lease contract may render it economically unattractive for it to do so, at least until the contract expires or is renegotiated.

Moreover, there are cases in which the routing of imports is restricted to a specific port by the shipper. Thus intermodal traffic is not entirely discretionary. At the same time, some truck-hauled traffic might be discretionary between two port regions, if cost and service to alternative ports are comparable. As noted above, this is the case for large regions of the U.S.

As a rough approximation, identifying the intermodal portion of port traffic as that portion of the total traffic that has a discretionary port routing is plausible, *in the short run*.

In the longer run, if the economics of alternative ports are significantly changed because of major changes in port charges, user access fees or inland transportation costs, traffic conventionally viewed as "local" or "not discretionary" may be induced to shift port routings. This leads to the notion of traffic that is *discretionary in the long run*.

With the notable exception of auto parts, the consultant believes the vast majority of containerized imports from Asia to the United States are retail goods. It is reasonable to expect that the geographical distribution of destinations for retail imports should be the same as the geographical distribution of retail sales. Furthermore, it is reasonable to expect that retail sales may be indexed to purchasing power in each region, i.e., average income times population in each region.

The consultant obtained population and personal income data by state from U.S. Dept. of Commerce web sites. This information, summarized by destination region, is displayed in Table 9. Figures in the table express the product of population and personal income per capita.

Table 10 compares total purchasing power shares of the ten destination regions with 1996 shares of total containerized cargo to and from Asia. We have assumed that the split of

[18] This is the case for the following studies: *San Pedro Bay Ports Long-Term Cargo Forecast – Final Report*, and *Ports of Los Angeles/Long Beach Transportation Study* (June, 2001).

traffic routed via East Coast and West Coast ports at that time was 18:82 in order to derive expected shares by region of total Asian containerized trade routed through West Coast ports. We have further assumed that all of the traffic routed via East Coast ports originated or terminated in the South and Neutral East regions. The 76.07% West Coast

Table 9
Relative Purchasing Power by Region

Region	Total Purchasing Power Percentage of all 50 states	 Percentage of Continental 48 states	States in Region
CA/NV	13.57	13.66	CA, NV
PNW	3.74	3.76	ID, OR, WA
AZ/NM	2.17	2.18	AZ, NM
Mid Rockies	2.81	2.82	UT, WY, MT, CO
Upper MW	2.32	2.34	ND, SD, MN
South	26.09	26.26	TX, OK, AR, TN, LA, MS, AL, GA, FL, SC, NC
Neutral East	48.65	48.97	NE, KS, IA, MO, IL, WI, MI, IN, OH, KY, PA, WV, VA, DC, MD, DE, NJ, NY, CT, RI, MA, VT, NH, ME
HI & AK	0.66		HI, AK

Source: U.S. Dept. of Commerce web sites.

Table 10
Comparison of Actual and Expected Regional Shares of U.S. – Asia Containerized Trade

Region	Proportion of Continental U.S. Personal Income	Estimated West Coast Share of Asia Trade (1996)	Expected Proportion of West Coast Total Loaded TEUs (1996)	Actual Proportion of West Coast Total Loaded TEUs (1996)
CA/NV	13.66%	100.00%	16.67%	44.16%
PNW	3.76%	100.00%	4.59%	11.53%
AZ/NM	2.18%	100.00%	2.66%	0.50%
Mid Rockies	2.82%	100.00%	3.44%	0.83%
Upper MW	2.34%	100.00%	2.86%	0.92%
South	26.26%	76.07%	24.37%	13.40%
Neutral East	48.97%	76.07%	45.43%	28.65%

share for the South and Neutral East regions is chosen so that the share of total U.S. – Asia containerized trade that passes through East Coast ports totals to 18%.

Note that there were many more containers terminating on the West Coast than could be explained by purchasing power in the West Coast regions, and many less in all other regions. In particular, about 44% of the total 1996 Asia – U.S. container cargo routed through West Coast ports terminated in California or Nevada, yet only about 17% was expected to do so based on these states' share of total continental U.S. personal income (and based on the assumed East Coast share of Asian trade). That is, traffic to/from CA/NV was *two and one half times* the amount expected based on purchasing power. (A smaller value assumed for the East Coast ports' share in 1996 would drive the value of this multiplier even higher.) It is simply not plausible that all of this cargo was consumed or produced in these two states.

We believe the explanation for this seeming anomaly is that much of the import traffic "terminating" in California actually were cargoes that were trans-loaded into trucks or domestic containers for re-shipment to other regions after re-mixing in a distribution center. Such re-shipments would be considered as "domestic" freight and excluded from the international traffic statistics. Also contributing to this traffic shift was traffic that underwent "value-added" transformation – ranging from insertion of hangers in garments up to use as a component of assembly of a larger manufactured good – and subsequently was shipped elsewhere in the U.S. as "domestic" freight.

A similar but smaller-scale statistical phenomenon is evident in the Pacific Northwest, where a 4.6% share was expected but the actual share was 11.5%. Note that all other regions have deficits of actual vs. expected shares, suggesting where the value-added transformations and trans-loads were shipped. There also may be some transloading of exports contributing to these numbers.

Transloading and value-added transformations of Asian imports are concentrated in Southern California for economic reasons, considering inventory economics, transportation economics and handling economics. Were these economics to change significantly, firms would experience an incentive to shift their transloading and value-added operations elsewhere. In that sense, their traffic is not really "local" traffic; instead, we term this traffic *discretionary in the long run*.

As a rough yardstick for quantifying discretionary traffic, we shall follow previous consulting studies and identify traffic moving intact in marine containers as inland-point rail intermodal traffic as the short-run discretionary traffic. But our long-run discretionary traffic includes this amount plus traffic to/from the West Coast regions that is in excess of that expected based on regional purchasing power. All purchasing-power-based traffic to/from the Mid Rockies region also is viewed as discretionary in the long run. (The rationale for this is that Mid Rockies is competitively served by the three port regions. While 16-18% portions of the PNW and AZ/NM regions were served by ports more distant than the nearest ones in the 1996 PIERS data, for simplicity we shall assume that traffic to/from these regions is local to the Seattle-Tacoma ports and to the Los Angeles-Long Beach ports, respectively.)

Expressed as a percentage of total Asia - West Coast containerized trade, the total short-run discretionary traffic handled through the West Coast ports is as follows (see Figure 7):

West Coast short-run discretionary traffic = **45%**

Per the discussion concerning Figure 7, the short-run discretionary traffic at the San Pedro Bay Ports is a smaller percentage:

SPB short-run discretionary traffic = **37%**

Total long-run discretionary traffic handled through the West Coast is computed as follows. First, we compute traffic to/from the West Coast regions expected on the basis of regional purchasing power:

West Coast local traffic = [(0.1667) + (0.0459) + (0.0266)] = 0.2392: **24%**

Long-run discretionary traffic is then computed as the complement:

West Coast long-run discretionary traffic = 1.00-0.2392 = 0.7608: **76%**

Assuming 69% of CA/NV and 100% of the AZ/NM purchasing-power-based traffic is assigned to the SPB Ports as "local" traffic, the resulting percentages of total SPB Ports' containerized cargoes that are discretionary are estimated as follows (all figures expressed as percentages of total SPB Ports' containerized cargoes):

SPB local traffic = 69% of CA/NV purchasing-power-based traffic plus 100% of the AZ/NM purchasing-power-based traffic =
[(0.69)(0.1667) + (0.0266)](5,002,779)/3,093,023 = 0.2291: **23%**

SPB long-run discretionary traffic = (100% - Local traffic) = 0.7709: **77%**

Including trans-loaded and value-added freight to/from other regions, we believe the total amount of discretionary traffic at the SPB Ports is a much larger figure than suggested by previous studies.

In addition to impacts on regional shares, transloading and value-added transformations have a profound impact on the modal share to and from the SPB Ports. We therefore analyze the economics of transloading in a subsequent section of this report. As will be discussed, these economics have changed significantly in recent years, with consequent significant shifts in modal shares.

Alternative West Coast Ports

Previous studies have examined differences in total steamship line costs and transit times to move loaded containers from Asian origins to US inland points via the various West Coast ports. The overall differences are relatively modest and they do not explain the ports' market shares.[19] The principal factors explaining the dominant share of the SPB Ports seem to be (1) large customers of the steamship lines have concentrated trans-loading activity in the hinterland of the SPB Ports, thereby adding a very large demand to the already-large Southern California demand, and (2) the lines choose to operate most vessel strings so as to carry a mix of all West Coast and inland destinations (as opposed to, say, operating separate "intermodal" vessels exclusively loaded with inland point intermodal cargoes). For such vessel strings it is most efficient to direct them to the largest market first (the SPB Ports) and off-load most or all inland cargoes there.

As will be discussed in Chapter 6, rail rates and transit times to most eastern points tend to be lowest from Southern California, next lowest from Seattle-Tacoma, next lowest from Oakland, next lowest from Vancouver, BC. But the differences across the West Coast ports are not large, all are competitive to most eastern points. Differences in the levels of capacity and congestion among the alternative West Coast ports are more important factors influencing market shares than the modest price and cost differences.

East Coast vs. West Coast Ports

The basic cost trade-off for routing Asian imports via East Coast ports vs. via West Coast ports is one of lower transportation costs via East Coast ports (because water-borne transport is much cheaper than rail or truck transport) vs. lower inventory costs via West Coast ports (because the mean transit time, and possibly the standard deviation of transit time, is lower using land transportation from West Coast ports than if using the all-water channel). Generally speaking, low-value goods destined to eastern markets are most efficiently handled using all-water supply channels via East Coast ports, while high-value goods are most efficiently handled via West Coast ports.

To quantitatively assess the trade-offs of routing via alternative ports and supply channels, analytical models of inventory costs (as a function of the mean and standard deviation of transit times) are developed in Chapter 5, and a tabulation of transportation charges for alternative ports of entry and supply channels is developed in Chapter 6.

4. STAKEHOLDER INTERVIEWS

The consultant endeavored to interview as many stakeholders as time and budget permitted. These interviews took place over the period December, 2004 – June, 2005.

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[19] See, for example, *San Pedro Bay Ports Long-Term Cargo Forecast*, Mercer Management Consulting, Inc.and Standard & Poor's DRI, 1998.

Stakeholders interviewed included ports, marine terminal and rail terminal operators, dray and trucking companies, third-party logistics and trans-loading service providers, intermodal marketing companies, railroads, steamship lines, and importers. By request of some of these parties, the specific companies interviewed are not identified in this report. In addition, comment on study plans and findings to date were solicited from participants in SCAG-organized Stakeholder Forums on 02/07/05 and 05/10/05. Comment on study plans and findings to date also were solicited from the SCAG Goods Movement Task Force on 01/19/05 and 03/16/05.

The stakeholders interviewed for this study provided valuable insights concerning current industry supply-chain practices and traffic volumes, components of transit time and transit time variability, components of transportation and handling expense, and components of inventory expense. However, it is to be emphasized that the modeling of transportation and inventory costs reported in Chapters 5 and 6 and the elasticity calculations reported in Chapter 8 are the original and independent work of the author. Stakeholders did not participate in the development of the Elasticity Model nor did they have any opportunity during the study to review or comment on analyses of container fees made using the model. The conclusions expressed in this report are solely those of the consultant and do not convey the views of any stakeholder.

5. INVENTORY COSTS

The choice of transportation mode and route by importers of Asian goods depends on a number of factors. Clearly, transportation charges for the alternative modes and routes are important. But other factors play an important role as well. Differences in transit time, in required inventory levels, and in labor required for labeling, repackaging, and other handling may result in substantial differences in inventory costs, handling costs and sometimes even significant differences in sales revenues. The economics of these factors therefore must be jointly analyzed with transportation costs.

In this chapter, economic models are developed to analyze inventory and distribution costs arising from these factors. Analytical methodology and supporting data are developed to compute the value to shippers of transit time, inventory and logistics factors as a function of commodity values.

Also discussed in this chapter are other factors that influence logistics decision-making, including re-packaging and labeling services by trans-loaders, the supply of 53-foot containers at various ports, the desire on the part of importers to diversify risks of delays from congestion arising in specific shipping channels or at specific ports.

Types of Inventory

Alternative strategies for goods imported from Asian vendors to U.S. demand points typically feature differences in the mean and standard deviation of transit time, as well as differences in the opportunity for consolidation and de-consolidation of shipments serving multiple demand points. These differences impact the inventory costs of the importer.

The vast majority of imports from Asia are retail goods. The origins for imports are typically factories in China and elsewhere in Asia, and the destinations are regional distribution centers (RDCs) that supply the importer's retail outlets or retail customers within the region. Differences in inventory costs resulting from use of alternative supply channels typically extend only as far as the RDC, not to the store or customer level.

There are two types of inventory costs influenced by the choice of supply channel. One is the working capital required to finance goods in transit (so-called "pipeline stock"). The other is working capital required to finance stocks of goods at destination RDCs. The overall stocks of goods at destination RDCs may be subdivided into what is called "cycle stock" and what is called "safety stock."

Average pipeline stock is simply the product of the average transit time and the average shipment size. Larger pipeline stocks result from using supply channels with longer transit times

At any given time, cycle stock at a shipment destination is the unused portion of the stock that arrived in the previous replenishment. This stock level equals the amount of the shipment just after a shipment arrives, then steadily drops to zero just before the next shipment arrives. Its average value is therefore equal to one half of the average shipment quantity.

Safety stock is required by retailers who strive to have stock on hand to service customer demands without delay. This stock level is maintained as a hedge against potential delays to shipments and potential errors in sales forecasts upon which the shipment quantities were based. That is, if customer demands are to be met without backorder, safety stocks are necessary to buffer against unpredictable surges in demand while replenishment orders are in transit and against unpredictable extensions in transit times for replenishments. Use of supply channels that entail a longer transit time and/or a more unreliable transit time result in the need for larger safety stocks at destinations.

As noted above, the vast majority of imports from Asia are retail goods. It is therefore important to understand the impact of the choice of supply channel on safety stock. Let us first consider the simplest case of a single destination for imported goods. Suppose the frequency of shipments from Asia is once every R time periods. Suppose the lead time between ordering goods from Asia and receipt at destination has mean value L and standard deviation σ_L. Further, suppose the mean absolute percentage error in sales forecasts made one period ahead is $MAPE$. The mean absolute deviation in forecast errors is defined as $MAD = MAPE * D$ where D is the expected (forecasted) demand per period. It is well-known that the standard deviation is related to the mean absolute deviation by

$$\sigma = (1.25)(MAD) = (1.25)(MAPE)(D)\ .$$ [20]

Considering the replenishment lead time and the frequency of replenishments, sales must be forecasted over an interval of length (L+R) in order to determine the proper quantity to be ordered from the Asian supplier. To analyze the impact of differences in lead time, the growth of forecast errors as a function of lead time must be characterized. Mathematically, the standard deviation of forecast errors grows with lead time according to the general model

$$\sigma_{R+L} = (L+R)^c\ \sigma_D$$

where c is a constant that depends on the correlation of week-to-week sales (i.e., does higher-than-expected sales last week imply higher-than-expected sales this week) and σ_D is the standard deviation of errors in one-period-ahead forecasts. Perfectly correlated sales would imply c=1. We shall assume in this analysis that c=0.5, which has been found to be accurate for household consumer products.[21] That is, to good approximation, forecast error grows as the square root of the time interval over which sales are forecasted. Hence the standard deviation of forecast errors over (L+R) is

$$\left(\sqrt{L+R}\right)\sigma_D\ .$$

As a function of the standard deviations of the transit time and the sales forecasting errors, the required level of safety stock ss may be expressed as

$$ss = k\sqrt{(L+R)\sigma_D^2 + D^2\sigma_L^2}$$

where R denotes the time between replenishments, L denotes the average transit time, σ_L denotes the standard deviation of transit time, D denotes the average shipment quantity per replenishment, σ_D denotes the standard deviation of forecast errors and k is a safety factor corresponding to the desired probability of no stockout.

To illustrate, suppose k = 2; this value corresponds to a 98% probability of no stockout, a typical value chosen for the safety factor. Suppose σ_L = 2.5 days, D = 1000 cases per day, σ_D = 200 cases, R = 3 days and L = 7 days. Then the required safety stock is

$$ss = 2\sqrt{(10)(40{,}000) + (1{,}000{,}000)(6.25)} = 5{,}158\ .$$

The average cycle stock at the destination is

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[20] Any of the many academic texts on production and inventory control would serve as a useful reference for the mathematics in this chapter. See, for example, *Decision Systems for Inventory Management and Production Planning,* E.A. Silver and R. Peterson, John Wiley & Sons, 1985.
[21] See "Optimal Planning and Control of Consumer Products Packaging Lines," in *Optimization in Industry*, T. A. Ciriani and R. C. Leachman, John Wiley & Sons, 1993.

$$(R)(D)/2 = (3)(1000)/2 = 1{,}500 \ ,$$

and the pipeline stock is

$$(L)(D) = 7{,}000 \ .$$

Thus, in this case, the safety stock at the destination is much larger than the cycle stock and equal to about 74% of the pipeline stock.

If the variability in transit time were reduced to $\sigma_L = 1.0$ days, the safety stock level would drop to $ss = 2{,}366$, i.e., a reduction of more than fifty percent. If in addition the mean lead time were reduced to 5 days, the safety stock level would drop to $ss = 1{,}131$, or about 22% of the required safety stock for the original data. The pipeline stock would drop to 5,000, i.e., $5/7^{ths}$ or about 71% of the required pipeline stock for the original data.

From this small example, one can conclude that (1) cycle stock is independent of the selection of a supply chain channel, (2) pipeline stock is linear in the average transit time, and (3) safety stock is non-linear and highly sensitive to the average and standard deviation of transit time.

Inventory Holding Costs

Typically, the cost of working capital is expressed as an interest rate times the amount of capital invested per unit inventory times the average inventory level. For the simple example above, the relevant inventory costs per unit time are expressed as

$$(i)(V_P)(L)(D) + (i)(V_{RDC})(ss)$$

where i is the interest rate, V_P is the amount of capital tied up in a unit of pipeline stock, $(L)(D)$ is the average pipeline inventory level, V_{RDC} is the amount of capital tied up in a unit of RDC safety stock, and ss is the level of safety stock at the RDC. (We have omitted the cost of cycle stock because that cost is independent of supply channel alternative.)

As imports move through the supply chain, they accumulate more cost. First, the vendor in Asia must be paid to procure the goods. Next, the local transportation in Asia and the steamship transit must be paid for. If other vendors are involved for North American landside handling, they must be paid. Finally, handling at the importer's own destination RDC entails more accumulated cost.

One index to the amount of capital tied up is the value declared to US customs. This value typically includes the cost of purchase of the goods from the Asian vendor plus the cost of transportation and logistics services up to the termination point for the importing carrier. If from that point onwards additional carriers or logistics providers are utilized to move the goods to the RDC, those costs are not included in the declared value. Costs of handling at the destination RDC also are not included.

For the purposes of this study, we shall make the assumption that pipeline inventories are valued by importers at 125% of the value declared to Customs. We shall further assume that RDC inventories are valued at 150% of the value declared to Customs.

The appropriate interest rate to apply depends on a number of factors. If the goods represent replenishment of goods with long-term demand, then an interest rate reflecting the cost of working capital for the importer is appropriate. A reasonable value for this is assumed to be 20 percent.

A higher interest rate is more appropriate if retail prices are declining with time or if the products experience rapid obsolescence, such as is the case for technology goods, style goods and goods for special sales events. For example, prices of many electronics products such as personal computers, video games, hand-held devices, etc., decline as much as fifty percent in the first year they are marketed and become completely obsolete within 2-3 years. Style goods are even more extreme, some having a selling season of only several months. In such cases, larger requirements for pipeline stocks and safety stocks result in revenue loss, and such losses should be accounted for in inventory costs. For such cases, a more appropriate value for the interest rate is 50 percent.

The sales of most retailers are a mixture of event items and standard items. We shall assume a simple average of the two cases, i.e., an interest rate of 35 percent is assumed for the purposes of costing pipeline and safety stocks. In the case of electronics and fashion item importers, we assume an interest rate of 50 percent.

Distribution of Values of Asian Imports

Inventory costs associated with both transit time and the location of mixing/distribution warehousing depend crucially on the values of the cargoes shipped. The best logistics strategy for merchants of, say, electronics or fashion apparel may be quite different than that for merchants of, say, furniture or textiles.

The consultant therefore undertook an effort to determine the distribution of declared values of containerized imports from Asia. Year 2003 customs data for U.S. West Coast ports, as summarized by PIERS and by the World Trade Atlas (WTA), was provided by the Port of Long Beach to the consultant. The PIERS data provided total TEUs imported from Asian origins through US West Coast ports, broken out by 100 commodity codes. The WTA data provided total declared values for the Asian imports passing through US West Coast ports, again broken out by the 100 commodity codes. The PIERS summarization of customs data includes logic to allocate Code 00, Miscellaneous Manufactured Goods, among other more specific categories, based on its reading of the description of the shipment contents on each bill of lading; the WTA summarization does not. In order to match PIERS and WTA data, the consultant therefore made a judgment to express Category 00 as a weighted combination of other commodity codes. This enabled the consultant to determine the average declared value per TEU for each of the 99 other (more specific) commodity codes.

Next, data from the Pacific Maritime Association web site was downloaded concerning the mix of 20-foot (12.3%), 40-foot (80.3%) and 45-foot containers (7.4%) carrying imports through West Coast ports during 2003. A further breakdown of 40-foot containers into standard (40%) and high-cube (60%) was assumed. Usable cubic capacities for these four sizes of marine containers are as follows:

20-foot: 1,169 cu. ft.
40-foot standard: 2,395 cu. ft.
40-foot high-cube: 2,684 cu. ft.
45-foot: 3,026 cu. ft.

The weighted-average cubic capacity per TEU works out to be 1,274.4 cu. ft. This in turn led to an estimate of the average declared value per cubic foot of shipping capacity for each commodity code. Table 11 displays the fourteen highest-volume commodity codes imported from Asia through US West Coast ports in 2003. The table also displays the average declared value per cubic foot of usable container capacity. As may be seen, furniture and bedding is the highest-volume commodity, with an average declared value of only $8.27 per cubic foot. Next highest is electronics and electrical equipment, with an average declared value of $37.46 per cubic foot, and so on.

Table 11
Total Volume and Average Declared Value by Commodity
For 2003 Asian Imports Through US West Cost Ports

Commodity	TEUs (1000s)	Average declared value ($ per Cu Ft)
Furniture & Bedding	1,014	8.27
Electronics & Elec Eqpt	749	37.46
Toys, Games & Sports Eqpt	663	16.56
Machinery	661	50.23
Vehicles & Parts	480	20.19
Plastic goods	353	13.18
Apparel - not knitted	329	27.93
Footwear	318	24.37
Misc manufactured goods	274	23.42
Steel goods	265	14.13
Leather goods	199	18.05
Rubber goods	198	14.63
Apparel – knitted	149	53.81
Ceramic goods	109	8.38
All other	1,460	

Source: PIERS, WTA and PMA data

The commodity codes were then grouped by ranges of declared values, resulting in a distribution of total shipment volume vs. average declared value. The results are graphed in Figure 8. The blue bars correspond to the raw data derived from PIERS, WTA and PMA databases. Because a single average declared value is associated with each of the 99 commodity codes in lieu of the actual range of declared values for each code, the depicted distribution is lumpier than reality. The real distribution of declared values must exhibit a Pareto or Poisson-like shape. The red line in the figure represents the consultant's smoothing of the raw data into a more realistic distribution. As may be seen, the distribution of declared values reaches a peak at the low end of the spectrum ($8-$12 per cubic foot of container capacity), with the distribution extending up to $175 per cubic foot in steadily declining volumes.

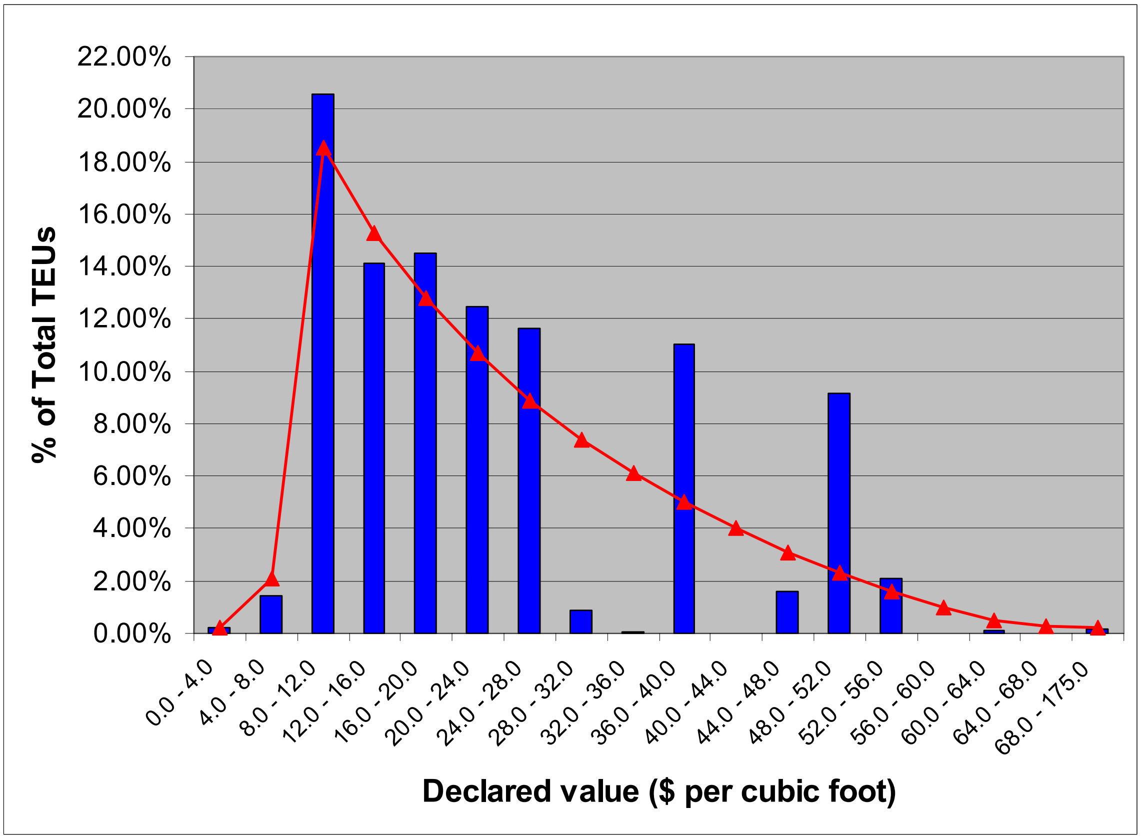


Figure 8.
Distribution of Declared Values for 2003 Asian Imports Through US West Coast Ports

It should be kept in mind that Figure 8 displays the value per cubic foot of container capacity and not the value per cubic foot of the actual cargo within the container. Anecdotal evidence we have received from trans-loaders suggests that, while shippers strive to fully utilize the available space, sometimes the full cubic capacity can not be utilized because of inability to stack cargoes, need for handling space, racking or blocking and bracing, etc. Moreover, some shipments, such as steel manufactured goods, may reach weight limits before cube limits.

A second factor to keep in mind is that the declared values reflect the manufactured or purchased cost of the goods in Asia rather than their retail values in North America. Retail values are roughly double the declared values.

Large Retail Merchant Importers

A different view of the PIERS data is a break-down by importer. The May 30, 2005 issue of the *Journal of Commerce* published a list of the top 100 US importers via ocean container transport. The consultant adopted this list, less 17 companies (all food and beverage, paper or chemical companies) who the consultant believes are not major importers of Asian goods. The remaining 83 are all large retailers or vendors of goods such as tires, electronics or appliances that are ready for retail marketing. While the imports these companies make are not solely sourced from Asia, the consultant believes the vast majority are. Moreover, the PIERS data is known to be very incomplete. For example, the *JOC* article lists Target Corp. as importing 202,700 TEUs in 2004. In contrast, Target Corp. advises the consultant that in 2004 it actually imported from Asia 315,766 TEUs, i.e., the PIERS figure for Target is low by more than a third.

Table 12 displays the resulting list of large retail merchant importers. Shown are the consultant's estimate for the average declared value of imports, the PIERS-reported volume, the volume inflated by 10% (a level that in the consultant's judgment is a suitable assumption for the merchant's import level from Asia, for the purposes of this study). Also shown is the average off-peak weekly volume to one of 21 equal-size demand regions spanning the continental United States. This is derived assuming 50% of the annual shipping is concentrated in three peak months of late summer and early fall.

Table 12
Largest US Importers of Asian Goods Via Ocean Container Transport

Importer	Type	Assumed avg. value per cu. ft. for Asian imports	PIERS 2004 Import Volume (TEUs)	Actual 2004 Asia Volume (TEUs)	Assumed 2004 Asia Volume (TEUs)	TEUs per week per region (off-peak)
Wal-Mart	Big box	$15	576,000		633,600	387
Home Depot	Furniture	$9	301,200		331,320	202
Target	Big box	$20	202,700	315,766	222,970	136
Sears (K-Mart)	Big box	$20	186,000		204,600	125
Ikea	Furniture	$9	100,000		110,000	67
Lowe's	Furniture	$9	100,000		110,000	67
Costco	Big box	$20	66,400		73,040	45

Ashley Furniture	Furniture	$9	63,800	70,180	43
Payless ShoeSource	Shoes	$25	54,200	59,620	36
Samsung	Electronics	$40	52,800	58,080	35
Matsushita	Electronics	$40	52,100	57,310	35
Toyota	Auto parts	$20	52,000	57,200	35
GE	Appliances	$25	51,800	56,980	35
Williams-Sonoma	Appliances	$25	50,000	55,000	34
Mattel	Toys	$17.50	49,300	54,230	33
Pier 1 Imports	Big box	$10	48,100	52,910	32
Nike	Shoes	$25	47,900	52,690	32
Sony	Electronics	$40	47,100	51,810	32
Michelin	Tires	$15	46,100	50,710	31
J C Penney	Big box	$20	45,000	49,500	30
LG	Electronics	$40	43,300	47,630	29
Bridgestone	Tires	$15	42,500	46,750	29
Limited Brands	Big box	$30	41,300	45,430	28
Dollar General	Big box	$15	40,000	44,000	27
Toys R Us	Toys	$17.50	39,300	43,230	26
Big Lots	Big box	$10.00	36,300	39,930	24
Ford	Auto parts	$20	29,700	32,670	20
Dorel	Furniture	$9	28,700	31,570	19
Nissan	Auto parts	$20	28,500	31,350	19
Yamaha	Auto parts	$20	27,300	30,030	18
Philips	Electronics	$40	27,200	29,920	18
Michaels Stores	Big box	$10	27,100	29,810	18
Whirlpool	Appliances	$25	26,800	29,480	18
Canon	Electronics	$40	26,200	28,820	18
Walgreen	Big box	$10	25,500	28,050	17
Rooms to Go	Furniture	$9	24,200	26,620	16
Thomson	Electronics	$40	24,200	26,620	16
Federated	Big box	$25	23,700	26,070	16
Emerson	Elec Eqpt	$40	22,600	24,860	15
Marubeni	Machinery	$50	21,800	23,980	15
Jarden	Appliances	$25	21,800	23,980	15
Reebok	Shoes	$25	20,600	22,660	14
Hankook	Tires	$15	20,400	22,440	14
Dollar Tree	Big box	$10	20,000	22,000	13
Natuzzi	Furniture	$9	19,654	21,619	13
Goodyear	Tires	$15	19,400	21,340	13
Family Dollar	Big box	$10	19,300	21,230	13
Retail Ventures	Big box	$15	18,800	20,680	13
TJX (T J Maxx)	Big box	$20	18,200	20,020	12
Sharp	Electronics	$40	17,900	19,690	12
Conair	Appliances	$25	17,800	19,580	12
Liz Claiborne	Apparel	$40	17,500	19,250	12
Toyo	Tires	$15	16,900	18,590	11
Toyota	Auto parts	$20	16,000	17,600	11
JoAnn Stores	Textiles	$20	15,900	17,490	11
FoxConn	Electronics	$40	15,400	16,940	10
Caterpillar	Machinery	$50	15,300	16,830	10

Gap	Apparel	$40	14,800	16,280	10
DaimlerChrysler	Auto parts	$20	14,600	16,060	10
May	Big box	$18	14,500	15,950	10
TPV International	Electronics	$40	14,500	15,950	10
Best Buy	Electronics	$40	14,400	15,840	10
Bombay	Furniture	$9	14,300	15,730	10
Fuji	Film	$80	14,300	15,730	10
BMW	Auto parts	$20	14,200	15,620	10
Haier	Appliances	$25	14,200	15,620	10
Hasbro	Toys	$17.50	14,200	15,620	10
Salton	Appliances	$25	14,100	15,510	9
Suzuki	Auto parts	$20	13,700	15,070	9
Linens 'n Things	Textiles	$20	13,600	14,960	9
OfficeMax	Big box	$12	13,400	14,740	9
Epson	Electronics	$40	13,400	14,740	9
Coaster of America	Furniture	$9	13,300	14,630	9
Staples	Big box	$12	13,200	14,520	9
Yazaki	Auto parts	$20	12,900	14,190	9
Ricoh	Electronics	$40	11,600	12,760	8
Brother	Electronics	$40	11,600	12,760	8
Applica	Appliances	$20	11,100	12,210	7
Adidas-Solomon	Shoes	$25	10,800	11,880	7
Footstar	Shoes	$25	10,500	11,550	7
Hamilton Beach	Appliances	$25	10,400	11,440	7
Honda	Auto parts	$20	10,300	11,330	7
CVS (Eckerds)	Big box	$10	10,200	11,220	7
Avg. value per cu ft		$18.79			
Total TEUs			3,447,654	3,792,419	
Subtotals:					
Big box			1,445,700	1,590,270	
Furniture			665,154	731,669	
Electronics			371,700	408,870	
Appliances			218,000	239,800	
Auto parts			219,200	241,120	
Tires			145,300	159,830	
Shoes			144,000	158,400	
Toys			102,800	113,080	
Elec eqpt			22,600	24,860	
Machinery			37,100	40,810	
Textiles			29,500	32,450	
Apparel			32,300	35,530	
Film			14,300	15,730	

As may be seen, the volume towards the end of the list is quite low; Eckerds is importing on average only 215.7 TEUs per week. If the Continental US were divided into 21 distribution regions, this would be only about 10 TEUs per week per region. The off-peak weekly volume per region is only 7 TEUs. For such merchants the transloading strategy is marginally feasible from a volume point of view, quite apart from whether or not it is economically attractive.

For the purposes of this study, the major importers listed above are considered to be the only candidates for transloading. As will be discussed in Chapter 7, these importers were subjected to an economic analysis to determine what import strategy (trans-load at one port, trans-load at multiple ports, direct shipping via nearest port, direct shipping via West Coast ports) is economically best.

The remaining total import volume from Asia is assumed to be confined to direct shipping and assumed to have cargo values distributed according to the red curve in Figure 8.

The Economic Impact of Consolidation and De-consolidation

The amount of safety stock required among several RDCs can be reduced if their shipments are consolidated for a portion of the overall lead time for replenishment, then de-consolidated according to updated demand forecasts. Because fluctuations in sales served by the various RDCs are partially off-setting, and because the impact of an extended transit time for one or several containers may be shared across the RDCs, much less safety stock is required at the destinations.

For example, suppose there are ten RDCs, each serving the same amount of retail demand. Suppose ten containers of goods are ordered each week, one for each RDC. If sales are 10% higher than expected at 5 RDCs but 10% lower at the other 5 RDCs, then no safety stock is required to meet demands if the ten shipments were consolidated. Further, suppose one of the 10 containers gets delayed by customs in Asia and misses its scheduled vessel and must transit on the next vessel one week later. If the ten shipments were pooled, each RDC could receive 90% of what was ordered. If not, one RDC would receive nothing. In the former case, a 10% safety stock is adequate; in the latter a 100% safety stock is required.

The consolidation-deconsolidation strategy is implemented by large, nationwide retailers as follows. Rather than shipping direct from Asia to its North American RDCs, shipments are made from Asian suppliers to de-consolidation facilities located in the hinterland of one or several North American ports of entry. Blanket orders covering nation-wide demands are issued to the vendors in Asia, typically on the order of 90 days before the desired shipment date. Not until shortly before vessel bookings are secured is the blanket order subdivided by port of entry, typically about 14 days before vessel departure. Total transit time to the North American port of entry, from the time containers are tendered at the origin port until the time containers can be picked up at the destination port, ranges from 14 to 30 days. Three days before arrival of a vessel at a destination port, the decision is made as to how to allocate the total shipment on the vessel among RDCs served by the port of entry, and this decision is electronically transmitted to the de-consolidation facility.

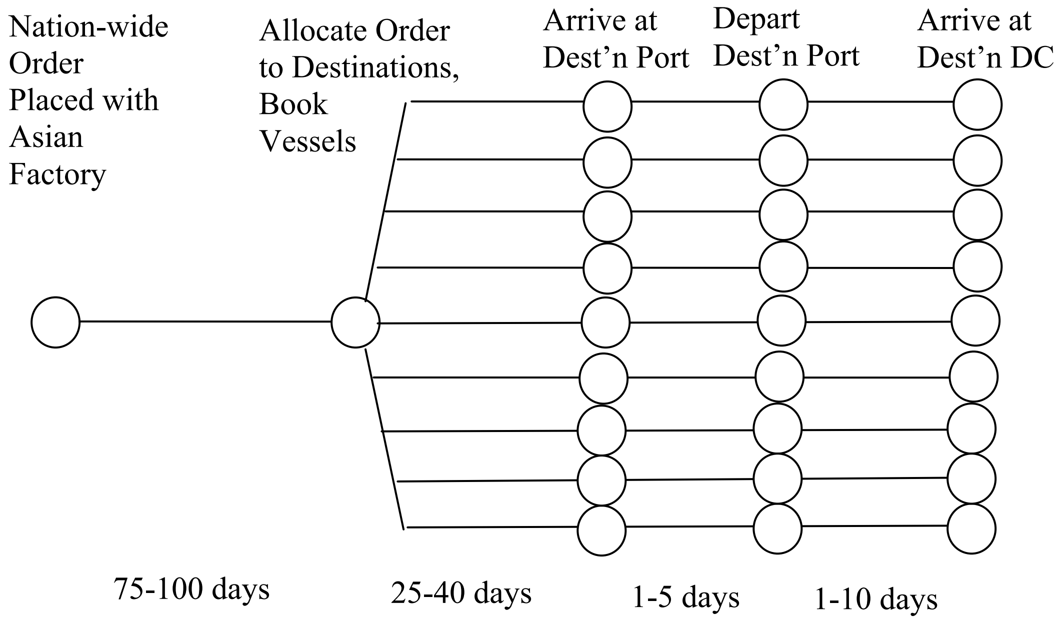
The importer conducting direct shipping from Asia to RDCs also can furnish its Asian vendors with blanket orders covering nationwide demands, but it must decide the RDC destination before booking vessels for departure from Asia. This avoids the extra handling cost and lead time of de-consolidation at the ports of entry, but it exposes the RDCs to forecast errors over a longer lead time and it denies the RDCs the opportunity to pool transit time risks.

The lead times for direct shipping and consolidation – deconsolidation are diagrammed in Figure 9. Under either alternative, blanket nation-wide orders may be placed with Asian suppliers, so that variations in demands across the importer's regional distribution centers are pooled. Under the direct shipping alternative, the order must be allocated to destination distribution centers before vessels are booked, resulting in 26 – 55 days of lead time exposure during which destination demands are not pooled. Under the trans-loading alternative, only the trans-load port is selected before vessel booking, and demands of distribution centers serviced by a single trans-load port are still pooled. Three days before vessel arrival at destination port, allocations are made to destination distribution centers, resulting in only 6 – 18 days of lead time exposure during which destination demands are not pooled.

Differences in transit time between the alternatives are explained as follows. From arrival at port of entry to departure from port of entry, the trans-loading alternative takes 2-3 days longer considering the priority given to inland-point intermodal shipments when unloading vessels and releasing boxes for pickup at marine terminals, the time to dray to the deconsolidation warehouse, the time to sort and trans-load goods, and the time to dray to the domestic rail ramp and await the next rail departure. From departure from port of entry to arrival at destination DC, transit time for the direct shipping alternative is 0-1 days longer because in many lanes marine stack trains have slower schedules than domestic container trains. Specific transit time assumptions by port and lane are provided in Tables 13 and 14.

To more easily quantify the safety stock savings from the consolidation-deconsolidation strategy, we first develop the mathematical formulas for safety stocks for the direct shipping and the consolidation-deconsolidation strategies for the simplified case of N equal-demand RDCs and M de-consolidation facilities each serving M/N RDCs.

Direct Shipping:



Transloading:

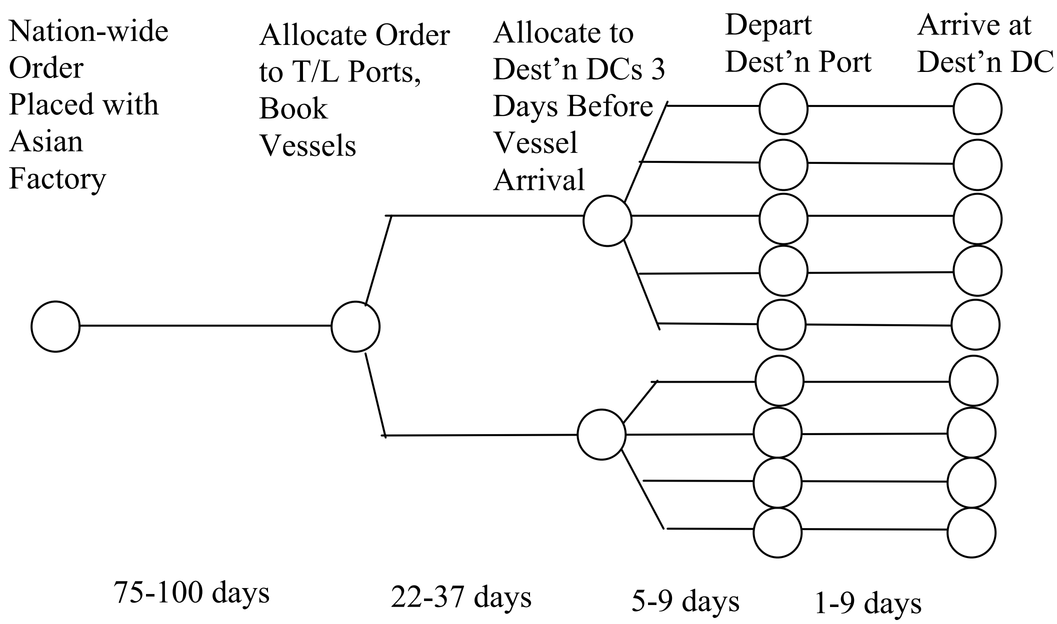


Figure 9
Structure of Ordering Lead Times
for Direct Shipping and Transloading Alternatives

Notation for Parameters:

D - nation-wide average sales volume per week (in physical units, not dollars).
$MAPE$ – mean absolute percentage error (expressed as a fraction of one) in one-week-ahead forecasts of nation-wide sales.
N – number of RDCs. The sales volume per week served by each RDC is initially assumed to be D/N. (We relax this assumption later on.)
M – number of ports carrying out trans-load de-consolidation of Asian shipments. Each such trans-load facility is assumed to supply N/M RDCs. (We generalize this later on.)
R – time between replenishment orders (from Asian suppliers). R is assumed to be 1 week for all importers.
L_{AO} – mean lead time (expressed in weeks) from when order is placed until port of entry for shipment is selected.
L_{AW} – mean lead time (expressed in weeks) from when port of entry for shipment is selected until shipment completes over-water transport from Asia and commences land transport from North American POE to RDC. In the case of trans-loading L_{AW} includes the time to trans-load the goods at a POE trans-loading facility.
L_W – mean lead time (expressed in weeks) from departure from point of origin until shipment commences land transport from POE to RDC. In the case of trans-loading L_W includes the time to trans-load the goods at a POE trans-loading facility.
L_{NA} – mean lead time (expressed in weeks) from when shipment commences land transport from POE until processed through the RDC.
$\sigma_{L_{AW}}$ – standard deviation of L_{AW}.
$\sigma_{L_{NA}}$ – standard deviation of L_{NA}.
k – safety factor determining the level of safety stocks at RDCs. (Choosing $k = 2$ implies approximately a 98% probability of no stock-out.)

Formula for Pipeline Stock

The total in-transit inventory is simply

$$(L_W + L_{NA})(D) . \tag{1}$$

Formulas for Safety Stocks

The standard deviation of errors in one-week-ahead forecasts of nation-wide sales is approximately given by

$$\sigma_D = (1.25)(MAPE)(D) .$$

Assuming independence of forecast errors across RDCs, the standard deviation of errors in one-week-ahead forecasts of sales served by a single RDC is

$$\sigma_D / \sqrt{N} .$$

The formulas for nation-wide safety stocks are different for the case of direct shipping from Asia to the RDCs and the case of de-consolidation of bulk shipments from Asia at a trans-load facility near the port of entry. We develop the formulas for these two cases as follows.

Direct Shipping

We assume uncertainties in water-side and land-side lead times are independent. We further assume errors in sales forecasts grow as the square root of lead time. If there were only a single RDC with demand rate D and variance of forecast errors σ_D^2, the generic formula for the required safety stock is

$$k\sqrt{L_{AO}\sigma_D^2 + (L_{AW} + L_{NA} + R)\sigma_D^2 + D^2(\sigma_{L_{AW}}^2 + \sigma_{L_{NA}}^2)}\ .$$

Considering the fleet of N RDCs each with demand rate D/N and variance of forecast errors σ_D^2/N, the required total nation-wide safety stock is

$$(k)\sqrt{L_{AO}\sigma_D^2 + N^2(L_{AW} + L_{NA} + R)(\sigma_D^2 / N) + N^2(D/N)^2(\sigma_{L_{AW}}^2 + \sigma_{L_{NA}}^2)}$$

or

$$(D)(k)\sqrt{\left[L_{AO} + (N)(L_{AW} + L_{NA} + R)\right](1.25)^2(MAPE)^2 + (\sigma_{L_{AW}}^2 + \sigma_{L_{NA}}^2)}\ . \quad (2)$$

De-consolidation at Trans-load Facilities

We assume each of the M trans-load facilities serves N/M RDCs. Fluctuations in demands among these RDCs over the lead time L_{AW} may be pooled. The generic formula for the total safety stock across N RDCs served by an individual trans-load facility is[22]

$$(k)\sqrt{(L_{AO})\sigma_D^2 + (L_{AW})\sigma_D^2 + (N)^2(L_{NA} + R)(\sigma_D^2 / N) + (N)^2(D/N)^2\left(\frac{\sigma_{L_{AW}}^2}{N} + \sigma_{L_{NA}}^2\right)}\ .$$

The total nation-wide safety stock in the case of M trans-load facilities each serving N/M RDCs is then

[22] The derivation of this formula for the case of $M = 1$ and no variance in lead times is provided in "Centralized Ordering Policies in a Multi-Warehouse System with Lead Times and Random Demand," by Gary Eppen and Linus Schrage, in *Multi-Level Production/Inventory Control Systems: Theory and Practice*, L. B. Schwarz, Editor, North Holland, 1981, pp. 51-68.

$$
(k)\begin{bmatrix} L_{AO}\sigma_D^2 + (M)^2(L_{AW})\sigma_D^2 / M \\ + N^2(L_{NA} + R)\sigma_D^2 / N \\ + (N)^2(D/N)^2(\frac{M}{N}\sigma_{L_{AW}}^2 + \sigma_{L_{NA}}^2) \end{bmatrix}^{1/2}
$$

or

$$
(D)(k)\sqrt{[L_{AO} + (M)(L_{AW}) + (N)(L_{NA} + R)](1.25)^2(MAPE)^2 + (\frac{M}{N}\sigma_{L_{AW}}^2 + \sigma_{L_{NA}}^2)}\ . \qquad (3)
$$

Note that if $M = N$, then (3) reduces to (2) (the formula for the case of direct shipping), as expected.

Numerical Examples

Suppose $N = 21$, $M = 3$, $D = 6{,}072$ TEUs per week, $MAPE = 0.06$, $L_{AO} = 7$, $L_{AW} = 4$, $L_W = 2$, $L_{NA} = 1$, $R = 1$, $\sigma_{L_{AW}} = 5/7$, $\sigma_{L_{NA}} = 1/7$ and $k= 2$. (These are believed to be fairly realistic data for a large US "big-box" retailer.)

Applying formula (1), the total pipeline inventory is

(2 + 1)(6,072) = 3D = 18,216 TEUs.

Next, we calculate safety stocks. Applying formula (2), direct shipping results in total nation-wide safety stock equal to

$(6{,}072)(2)\ [(7 + (21)(4+1+1))(1.25)^2(0.06)^2 + (5/7)^2 + (1/7)^2\ ]^{½} = 2.262D = 13{,}733$ TEUs.

Applying formula (3), de-consolidation of Asian imports at three trans-load facilities results in a nation-wide safety stock equal to

$(6{,}072)(2)\ [(7 + (3)(4) + (21)(1+1))(1.25)^2(0.06)^2 + (1/7)(5/7)^2 + (1/7)^2\ ]^{½} = 1.321D = 8{,}023$ TEUs.

Note that the trans-loading option reduces RDC safety stocks by (2.262 – 1.321) = 0.941 weeks of demand. Put another way, the retailer's supply chain is reduced by about 7 days.

Let's suppose the investment in landed imports is $20 per cubic foot, assume 1,250 usable cubic feet per TEU, and assume an inventory carrying cost of 20% per year.

For direct shipping, the total inventory cost is

$$(18{,}216 + 13{,}733)(1{,}250)(\$20)(0.20/52) = \$3{,}072{,}019 \text{ per week}$$

or about $159.7 million per year.

The savings in nation-wide safety stock from de-consolidation at the POEs is calculated as

$$(13{,}733 - 8{,}023)(1{,}250)(\$20)(0.20/52) = \$549{,}038 \text{ per week}$$

or about $28.6 million per year.

Expressed a different way, the de-consolidation savings per cubic foot of imports is

$$(\$549{,}038) / [(6{,}072)(1{,}250)] = \$0.0723$$

This savings is linear in the total import volume, the value of the imports and in the assumed inventory carrying cost, but it is non-linear in the numbers of RDCs and POEs, the forecast error, and the standard deviations of the lead times. Advantages from de-consolidation grow with

- Increasing import volume (linearly)
- Increasing import value (linearly)
- Increasing inventory carrying cost (linearly)
- Increasing numbers of RDCs (square root function)
- Decreasing numbers of POEs (square root function)
- Avg. forecast error (square root function)

To illustrate, if we reduce N to 7 but keep $M = 3$, the savings declines to $0.0379 per cubic foot. i.e., abut half. Even if M is reduced to 1 (while N is 7), the savings is reduced to $0.0561 per cubic foot. This suggests that de-consolidation is much more attractive to relatively large retailers with a nation-wide or nearly nation-wide market. In particular, de-consolidation offers no savings at all to the retailer with only one nation-wide distribution center (as there is nothing to consolidate).

If we keep $N = 21$ but reduce M to 1, the savings grows from $0.0732 to $0.0839, i.e., by about a penny per cubic foot. This suggests that if the total of transportation plus pipeline inventory costs is significantly lowered by using multiple ports of entry, then it is efficient to carry out trans-loading and de-consolidation at several ports situated to take advantage of land transportation economies (e.g., Los Angeles, Seattle and Norfolk) rather than at just one (e.g., Los Angeles).

Finally, if we again consider the case of $N = 21$ and $M = 1$ but set $MAPE = 0.09$ (as might be the case for new electronics or style goods), the savings from transloading is $0.0988. This suggests that for such kinds of items, consolidation-deconsolidation is extremely valuable, as it is essential to be able to control inventories as tightly as possible.

The Impact of Congestion

Suppose the trans-loading channel suffers congestion (e.g., a severe shortage of draymen), while the direct-shipping channel does not (e.g., it uses on-dock rail). We retain the original example data except we suppose for the trans-loading channel that $L_{NA} = 2$, and $\sigma_{L_{NA}} = 4/7$. That is, transit times to pass through the POE rise by a week, and the standard deviation grows by three days. In this situation, the savings in nation-wide safety stock for the trans-loading option over the direct shipping option drops to \$0.0312 per cubic foot. If the standard deviation was even worse, e.g., $\sigma_{L_{NA}} = 7/7$, then the cost of safety stock becomes \$0.0201 *more* per cubic foot than that for the direct shipping option. It is clear that the impact of congestion is economically very severe for retailers, to the point that it may become necessary for them to abandon de-consolidation in favor of direct shipping, if that is the only way that the congestion can be avoided.

Generalization for Varying Lead Times and Volumes

The general case is where there are multiple North American ports of entry and multiple destination RDCs. The different combinations have different lead times. Moreover, the volumes at the various RDCs are not necessarily equal. The complex formulas for the general case are provided in the appendices.

Assumed Values of Lead Time Parameters

Lead time parameters for assessing inventory costs were assumed as follows:

L_{AO} – 60 days
L_{AW} – 24.5 days plus vessel transit time plus port-to-ramp time for inland rail intermodal shipments of marine containers
L_{AW} – 24.5 days plus vessel transit time plus port-to-gate time for truck or local dray shipments of marine containers
L_{AW} – 24.5 days plus vessel transit time plus port-to-warehouse transit time for deconsolidation/trans-load shipments
L_{NA} – truck transit time for inland truck shipment of marine containers
L_{NA} – rail transit time plus one day for inland rail intermodal shipments of marine containers
L_{NA} – one day for local delivery of marine containers
L_{NA} – two days plus rail transit time for trans-loaded inland rail intermodal shipments
L_{NA} – truck transit time for inland truck shipment of trans-loaded cargo
L_{NA} – one day for local delivery of trans-loaded cargo

Port-related transit time parameters were assumed as shown in Table 13.

Table 13
Assumed Lead Time Parameters

Port	Asia to Port		Port to Mount (on-dock rail)		Port to Gate (off-dock rail and truck)		Port to T/L Whse	
	Mean	Std Dvn	Mean	Std Dvn	Mean	Std Dvn	Mean	Std Dvn
Vancouver	16	5	2	2	3	2	3	2
Seattle-Tacoma	15	5	2	2	3	2	3	2
Oakland	15	5	2	2	3	2	3	2
LA-Long Beach	14	5	2	2	3	2	3	2
Houston	22	5	2	2	3	2	2	2
Savannah	28	5	2	2	3	2	2	2
Charleston	27	5	2	2	3	2	2	2
Norfolk	28	5	2	2	3	2	2	2
NY-NJ	26	5	2	2	3	2	3	2

In addition to the above, direct rail movement of marine containers was assumed to have a standard deviation of 3 days. Rail movement of trans-loaded cargo (in domestic containers) was assumed to have a standard deviation of 1 day. Truck and local dray movements were assumed to have a standard deviation of 0.25 days.

Transit Times for Inland Movements

The mean transit times for inland truck and rail movements depend on origin-destination pairs. Average transit time parameters, expressed in days, were established for each channel from each port to each destination. For rail movements, rail schedules (showing total hours from cut-off at origin ramp to release at destination ramp and showing frequency of service) were obtained from various rail and service web sites. Generally, an extra day at destination was added to allow for drays to and from rail ramps. For transcontinental, inter-railroad movements of marine carriers, the consultant sometimes added an extra day or two based on our experience. For truck movements, the consultant estimated transit times directly. These transit times are summarized in Table 14.

Table 14
Assumed Mean Transit Times for Inland Truck and Rail Movement (Days)

Port	Destination	Rail - 40ft Container	Rail 53ft Container	Direct Truck
Charleston	Atlanta	2	2	1

Charleston	Baltimore	3	1	2
Charleston	Boston	4	3	3
Charleston	Charleston	NA	NA	NA
Charleston	Charlotte	3	NA	1
Charleston	Chicago	4	4	3
Charleston	Cleveland	5	5	2
Charleston	Columbus	5	5	2
Charleston	Dallas	4	3	3
Charleston	Harrisburg	5	4	2
Charleston	Houston	6	6	3
Charleston	Kansas City	7	6	3
Charleston	Los Angeles	NA	NA	6
Charleston	Memphis	3	3	2
Charleston	Minneapolis	5	5	4
Charleston	New York	4	2	2
Charleston	Norfolk	3	2	1
Charleston	Oakland	NA	NA	7
Charleston	Pittsburgh	6	5	2
Charleston	Savannah	3	2	1
Charleston	Seattle-Tacoma	NA	NA	7
Charleston	Toronto	7	7	3
Houston	Atlanta	5	4	2
Houston	Baltimore	6	5	3
Houston	Boston	7	6	4
Houston	Charleston	6	6	3
Houston	Charlotte	6	6	3
Houston	Chicago	4	4	3
Houston	Cleveland	5	4	3
Houston	Columbus	5	4	3
Houston	Dallas	2	1	1
Houston	Harrisburg	6	5	4
Houston	Houston	NA	NA	NA
Houston	Kansas City	4	4	2
Houston	Los Angeles	7	7	4
Houston	Memphis	3	3	2
Houston	Minneapolis	7	7	3
Houston	New York	7	7	4
Houston	Norfolk	7	6	3
Houston	Oakland	NA	NA	5
Houston	Pittsburgh	6	5	4
Houston	Savannah	7	6	3
Houston	Seattle-Tacoma	NA	NA	6
Houston	Toronto	8	8	5
LA-Long Beach	Atlanta	8	6	6
LA-Long Beach	Baltimore	9	7	7
LA-Long Beach	Boston	9	7	8
LA-Long Beach	Charleston	10	8	6
LA-Long Beach	Charlotte	9	8	6
LA-Long Beach	Chicago	6	5	4
LA-Long Beach	Cleveland	8	6	5

LA-Long Beach	Columbus	8	6	5
LA-Long Beach	Dallas	6	4	3
LA-Long Beach	Harrisburg	9	7	6
LA-Long Beach	Houston	6	4	4
LA-Long Beach	Kansas City	6	4	3
LA-Long Beach	Los Angeles	NA	NA	NA
LA-Long Beach	Memphis	6	5	4
LA-Long Beach	Minneapolis	8	7	4
LA-Long Beach	New York	9	7	7
LA-Long Beach	Norfolk	9	8	7
LA-Long Beach	Oakland	NA	NA	1
LA-Long Beach	Pittsburgh	8	6	6
LA-Long Beach	Savannah	10	8	6
LA-Long Beach	Seattle-Tacoma	4	3	3
LA-Long Beach	Toronto	8	7	6
Norfolk	Atlanta	3	3	2
Norfolk	Baltimore	4	4	1
Norfolk	Boston	5	5	2
Norfolk	Charleston	3	2	2
Norfolk	Charlotte	2	2	1
Norfolk	Chicago	4	3	2
Norfolk	Cleveland	4	4	2
Norfolk	Columbus	4	4	2
Norfolk	Dallas	5	5	3
Norfolk	Harrisburg	4	4	1
Norfolk	Houston	6	6	3
Norfolk	Kansas City	6	5	3
Norfolk	Los Angeles	NA	NA	7
Norfolk	Memphis	4	3	2
Norfolk	Minneapolis	7	4	3
Norfolk	New York	4	4	1
Norfolk	Norfolk	NA	NA	NA
Norfolk	Oakland	NA	NA	7
Norfolk	Pittsburgh	4	4	2
Norfolk	Savannah	4	3	2
Norfolk	Seattle-Tacoma	NA	NA	7
Norfolk	Toronto	6	5	2
NY-NJ	Atlanta	4	2	2
NY-NJ	Baltimore	NA	NA	1
NY-NJ	Boston	NA	NA	1
NY-NJ	Charleston	5	5	2
NY-NJ	Charlotte	4	4	2
NY-NJ	Chicago	3	2	2
NY-NJ	Cleveland	3	3	2
NY-NJ	Columbus	3	3	2
NY-NJ	Dallas	6	5	4
NY-NJ	Harrisburg	NA	NA	1
NY-NJ	Houston	8	6	4
NY-NJ	Kansas City	5	4	3
NY-NJ	Los Angeles	NA	NA	7

NY-NJ	Memphis	5	4	3
NY-NJ	Minneapolis	5	3	4
NY-NJ	New York	NA	NA	NA
NY-NJ	Norfolk	3	2	1
NY-NJ	Oakland	NA	NA	7
NY-NJ	Pittsburgh	3	3	1
NY-NJ	Savannah	5	5	3
NY-NJ	Seattle-Tacoma	NA	NA	7
NY-NJ	Toronto	4	3	2
Oakland	Atlanta	9	7	6
Oakland	Baltimore	10	7	7
Oakland	Boston	10	7	8
Oakland	Charleston	11	9	7
Oakland	Charlotte	9	9	7
Oakland	Chicago	7	5	5
Oakland	Cleveland	9	6	6
Oakland	Columbus	9	7	6
Oakland	Dallas	7	5	3
Oakland	Harrisburg	10	8	7
Oakland	Houston	7	5	3
Oakland	Kansas City	7	5	3
Oakland	Los Angeles	NA	NA	1
Oakland	Memphis	7	5	4
Oakland	Minneapolis	8	7	5
Oakland	New York	10	8	7
Oakland	Norfolk	10	7	7
Oakland	Oakland	NA	NA	NA
Oakland	Pittsburgh	9	7	6
Oakland	Savannah	11	9	7
Oakland	Seattle-Tacoma	NA	NA	2
Oakland	Toronto	9	8	7
Savannah	Atlanta	1	1	1
Savannah	Baltimore	3	2	2
Savannah	Boston	3	3	3
Savannah	Charleston	NA	NA	1
Savannah	Charlotte	3	3	1
Savannah	Chicago	4	3	3
Savannah	Cleveland	5	4	3
Savannah	Columbus	4	4	3
Savannah	Dallas	4	4	4
Savannah	Harrisburg	5	4	3
Savannah	Houston	5	4	4
Savannah	Kansas City	6	4	4
Savannah	Los Angeles	NA	NA	6
Savannah	Memphis	3	3	2
Savannah	Minneapolis	7	4	4
Savannah	New York	4	2	3
Savannah	Norfolk	3	2	2
Savannah	Oakland	NA	NA	6
Savannah	Pittsburgh	5	4	3

Savannah	Savannah	NA	NA	NA
Savannah	Seattle-Tacoma	NA	NA	7
Savannah	Toronto	7	7	5
Seattle-Tacoma	Atlanta	9	7	5
Seattle-Tacoma	Baltimore	9	7	5
Seattle-Tacoma	Boston	9	8	5
Seattle-Tacoma	Charleston	11	8	5
Seattle-Tacoma	Charlotte	10	9	5
Seattle-Tacoma	Chicago	6	5	3
Seattle-Tacoma	Cleveland	8	6	4
Seattle-Tacoma	Columbus	8	6	4
Seattle-Tacoma	Dallas	8	8	4
Seattle-Tacoma	Harrisburg	9	7	5
Seattle-Tacoma	Houston	10	7	5
Seattle-Tacoma	Kansas City	8	6	3
Seattle-Tacoma	Los Angeles	4	3	2
Seattle-Tacoma	Memphis	8	7	4
Seattle-Tacoma	Minneapolis	5	4	3
Seattle-Tacoma	New York	9	7	5
Seattle-Tacoma	Norfolk	9	8	5
Seattle-Tacoma	Oakland	NA	NA	2
Seattle-Tacoma	Pittsburgh	9	6	4
Seattle-Tacoma	Savannah	11	11	6
Seattle-Tacoma	Seattle-Tacoma	NA	NA	NA
Seattle-Tacoma	Toronto	8	7	4
Vancouver, BC	Atlanta	9	8	5
Vancouver, BC	Baltimore	10	8	5
Vancouver, BC	Boston	10	8	5
Vancouver, BC	Charleston	11	10	5
Vancouver, BC	Charlotte	10	9	5
Vancouver, BC	Chicago	7	5	3
Vancouver, BC	Cleveland	9	7	4
Vancouver, BC	Columbus	9	7	4
Vancouver, BC	Dallas	9	9	4
Vancouver, BC	Harrisburg	10	8	5
Vancouver, BC	Houston	12	9	5
Vancouver, BC	Kansas City	9	8	3
Vancouver, BC	Los Angeles	NA	NA	2
Vancouver, BC	Memphis	7	6	4
Vancouver, BC	Minneapolis	6	5	3
Vancouver, BC	New York	10	8	5
Vancouver, BC	Norfolk	10	9	5
Vancouver, BC	Oakland	NA	NA	2
Vancouver, BC	Pittsburgh	10	7	4
Vancouver, BC	Savannah	11	11	6
Vancouver, BC	Seattle-Tacoma	NA	NA	1
Vancouver, BC	Toronto	6	5	4

6. TRANSPORTATION CHARGES

There are many individual transportation charges assessed by various parties concerning the movement of containerized imports. Some of these charges are specifically billed to importers, some are absorbed by carriers and covered by their overall rate charged to the importer. Table 15 documents various land-side charges and distinguishes those billed to the customer vs. those absorbed by the carrier. Three types of carriers are shown: steamship line, non-vessel-owning common carrier, and intermodal marketing company.

For the purposes of this study, a matrix of transportation and handling charges as faced by importers was developed for specific ports of entry and alternative modes of transport as follows.

Alternative Ports of Entry

Ten major North American ports of entry were included in the analysis, as follows:

Vancouver, BC. Assumed trans-load warehouse site is Abbotsford, BC.
Seattle-Tacoma, WA. Assumed trans-load warehouse site is Fife, WA.
Oakland, CA. Assumed trans-load warehouse site is Tracy, CA.
Los Angeles – Long Beach, CA. Assumed trans-load warehouse site is Ontario, CA.
Houston, TX. Assumed trans-load warehouse site is Baytown, TX.
Savannah, GA. Assumed trans-load warehouse site is Garden City, GA.
Charleston, SC. Assumed trans-load warehouse site is Summerville, SC.
Norfolk, VA. Assumed trans-load warehouse site is Suffolk, VA.
Port of New York – New Jersey. Assumed trans-load warehouse site is 50% East Brunswick, NJ and 50% Allentown, PA.

There are other ports handling Asian imports to North America, but in much smaller volumes than handled by the above ports. There also are prospects or potential for future volumes of Asian cargoes to US destinations through the Ports of Manzanillo and Lazaro Cardenas and a proposed new port near Ensenada, all on the West Coast of Mexico. However, US-destined volume via the Mexican ports at this time is negligible, and rate quotations are scarce or nonexistent. Prince Rupert, BC also is a prospective port of entry, but again rate quotations are unavailable at this time.

Destinations

The typical large US importer/retailer operates regional distribution centers that restock retail stores located within an overnight driving distance. Typically, on the order of 15-30 regional centers are required to service all the retail outlets within the continental United States and Canada. This suggests that a reasonable approximation of import trade flows may be made by considering a comparable number of destination zones, each with one regional distribution center as a destination for Asian imports.

To model inland transportation costs, the continental United States was divided into 21 destination regions. It was assumed that a regional distribution center (RDC) located in a suburb of a major city within each region was the destination for all imported goods consumed within the region, as detailed below. Transportation costs for alternative modes/channels for Asian imports via alternative potential ports of entry to these distribution center sites were developed.

The destination regions and assumed site of the RDC within the region are as follows:[23]

Seattle Region – including Washington, Oregon, Idaho and Montana. Regional distribution center assumed to be in Fife, WA.
Oakland Region – including Wyoming, 50% of Colorado, 67% of Utah, 34% of California, and 33% of Nevada. Regional distribution center assumed to be in Tracy, CA.
Los Angeles Region – including Arizona, New Mexico, 66% of California, 67% of Nevada, 33% of Utah, and 50% of Colorado. Regional distribution center assumed to be in Ontario, CA.
Dallas Region – including Oklahoma and 50% of Texas. Regional distribution center assumed to be in Midlothian, TX.
Houston Region – including Louisiana, Mississippi and 50% of Texas. Regional distribution center assumed to be in Baytown, TX.
Memphis Region – including Arkansas, Tennessee and Kentucky. Regional distribution center assumed to be in Millington, TN.
Kansas City Region – including Kansas, Nebraska, Iowa and Missouri. Regional distribution center assumed to be in Lenexa, KS.
Minneapolis Region – including North Dakota, South Dakota, Minnesota and 50% of Wisconsin. Regional distribution center assumed to be in Rosemount, MN.
Chicago Region – including Illinois, Indiana, Michigan 50% of Wisconsin. Regional distribution center assumed to be in Joliet, IL.
Columbus Region – including 50% of Ohio. Regional distribution center assumed to be in Springfield, OH.
Cleveland Region – including 50% of Ohio and 25% of New York. Regional distribution center assumed to be in Chagrin Falls, PA.
Pittsburgh Region – including West Virginia and 50% of Pennsylvania. Regional distribution center assumed to be in Beaver Falls, PA.
Harrisburg Region – including 50% of Pennsylvania. Regional distribution center assumed to be in Allentown, PA.
Atlanta Region – including Alabama, Georgia and 50% of Florida. Regional distribution center assumed to be in Duluth, GA.

[23] A percentage specified for a state defines the portion of import volume terminating in that state that is assumed to be assigned to a distribution center in the named region. For example, 50% of imports terminating in Pennsylvania are assumed to be served from an importer's Harrisburg Region distribution center, and 50% are assumed to be served from the importer's Pittsburgh Region distribution center.

Table 15
Transportation Costs – Charges Separately Billed to Customer vs. Charges Absorbed by Carrier
(“Yes” indicates charge is separately billed to customer by carrier, “No” indicates charge is absorbed by carrier and must be covered by overall rate)

Type of Charge	**Carrier Type**		
	SSL on through B/L	NVOCC on through B/L	IMC B/L
Terminal gate charge for truck/dray	No, always paid by SSL		
JPA terminal gate charge (Alameda Corr.)	No, always paid by SSL/collected by RR		
PierPass charge for truck/dray	Yes - surcharge always paid by customer		
Dray to warehouse in Port of Entry hinterland	Yes for Group 4 rate	Yes for Port B/L	
Trans-load from marine container to domestic trailer or domestic container	Not involved	Yes	
Truck line-haul of marine container	Yes for Group 4 rate	Yes for Port B/L	
Truck line-haul of domestic trailer	Not involved	Yes	
Dray of domestic trailer or container from warehouse to origin rail ramp	Not involved	Yes	
Rail line-haul of marine container	No for MLB/IPI	Yes for SSL Port B/L No for SSL IPI B/L	Yes for Third Party International (TPI)
Destination dray of marine intermodal container	Yes for SDD B/L No for CY B/L	Yes for SDD B/L No for CY B/L	
Rail line-haul of domestic trailer or container	Not involved	In some cases – but most likely not	Yes
Destination dray of domestic intermodal trailer or container			
Third party booking fee (IMC) for rail intermodal movement			

Abbreviations: B/L – bill of lading, SSL – steamship line, NVOCC – non-vessel-owning common carrier, IMC – intermodal marketing company, MLB – mini-land-bridge, IPI – inland point intermodal, SDD – store-door delivery, CY – container yard pick-up by customer, Group 4 rate – applies to store-door delivery in the Port of Entry hinterland.

Savannah Region – including Florida. Regional distribution center assumed to be in Garden City, GA.
Charleston Region – including 50% of South Carolina. Regional distribution center assumed to be in Summerville, SC.

Charlotte Region – including North Carolina and 50% of South Carolina. Regional distribution center assumed to be in Salisbury, SC.
Norfolk Region – including Virginia. Regional distribution center assumed to be in Suffolk, VA.
Baltimore Region – including Maryland, DC and Delaware. Regional distribution center assumed to be in Frederick, MD.
New York Region – including New Jersey, Connecticut and 75% of New York. Regional distribution centers are assumed to be located 50% in East Brunswick, NJ and 50% in Allentown, PA.
Boston Region – including Rhode Island, Massachusetts, New Hampshire, Vermont and Maine. Regional distribution center assumed to be in Milford, MA.

For the purposes of the elasticity analysis in Chapter 8, the distribution of import volumes by destination region was assumed to be proportional to total purchasing power in each region. Data on per-capita personal incomes by state and state populations were obtained by the consultant from US Dept. of Commerce web sites, then aggregated into the regions as defined above. The results are displayed in Table 16. This distribution is assumed to apply to all of the 83 major importers as well as every category of proxy miscellaneous importer listed in Chapter 6.

Transportation Modes

When considering the shipment of containerized Asian imports to North America there are various options available to importers:

- Alternative vessel operating common carriers and non-vessel operating common carriers (NVOCCs), and alternative ports of entry.
- Through movement of marine containers from port of entry to inland destination via local dray ("Direct Dray") or long-haul truck ("Direct Truck").
- Through movement of marine containers from port of entry to inland destination via rail double-stack train and final dray from rail terminal to destination. An initial dray from port terminal to origin rail terminal is required if the rail terminal is not on-dock ("Direct Rail").
- Dray of marine containers from port of entry to a transloading warehouse in the hinterland of the port of entry, transloading to the goods to a 53-foot trailer for truck movement to inland destination or local dray ("Trans-load Truck" or "Local Trans-load").
- Dray of marine containers from port of entry to a transloading warehouse in the hinterland of the port of entry, transloading to the goods to a 53-foot trailer, dray to origin rail terminal, rail movement of the 53-foot trailer via premium intermodal train service, and final dray from rail terminal to destination ("Trans-load Rail Trailer").
- Dray of marine containers from port of entry to a transloading warehouse in the hinterland of the port of entry, transloading to the goods to a 53-foot container, dray to origin rail terminal, rail movement of the 53-foot container via double

stack train, and final dray from rail terminal to destination ("Trans-load Rail Container").

Table 16
Assumed Distribution of Import Volumes by Destination Region

Region	Percentage of total imports
Seattle-Tacoma	4.024
Oakland	6.629
LA-Long Beach	11.782
Dallas	4.572
Houston	5.576
Memphis	3.765
Kansas City	4.219
Minneapolis	3.262
Chicago	10.990
Cleveland	3.807
Columbus	1.888
Pittsburgh	2.653
Atlanta	6.915
Savannah	2.811
Charleston	0.597
Charlotte	3.220
Harrisburg	2.161
Norfolk	2.740
Baltimore	2.870
New York	11.229
Boston	4.290
Total	100.000

The portions of the overall movement of each vehicle type (marine container, 53-foot trailer or 53-foot container) may be procured separately from multiple vendors, or they may be purchased as a bundled service from a single service provider. The vendors may be carriers or they may be third parties such as NVOCCs or intermodal marketing companies (IMCs).

Further complexity arises because many rates are contractual and confidential, with different rates applying to different customers.

The consultant was able to view rates offered by various vendors. The costs reported herein are based on averages across baskets of rates charged by various vendors to various customers and therefore do not necessarily reflect the specific rates of any individual contract or individual carrier.

Components of Transportation Costs

Costs components that were estimated are:

- All modes/channels: steamship line rate from Shanghai to dockside at each port of entry for a 40-foot container, plus wharfage and landing charges absorbed by the line
- Direct Rail: Weighted average of JPA gate charge, dray to near-dock rail ramps and dray to off-dock rail ramps
- Direct Rail of 40-foot container: Rail line haul rate (Note: This is an estimation of the difference between steamship rate for store-door delivery at a warehouse site near port of entry and steamship rate for inland point intermodal.)
- Direct Rail of 40-foot container: Destination dray
- Direct Truck or Direct Dray of 40-foot container: Truck line haul rate or local dray rate
- All trans-load modes: Dray from port to site of trans-load warehouse plus trans-loading fee
- Trans-load Rail Container: Dray from trans-load warehouse to domestic rail ramp
- Trans-load Rail Container: Rail line haul rate
- Trans-load Rail Container: Destination dray
- Trans-load Rail Container: Third-party (e.g., IMC) booking fee
- Trans-load Truck or Local trans-load: Truck line haul rate or local dray rate

In certain cases, weighted-averages of charges serve as the basis for costs, such as weighted averages of dray rates to near-dock terminals, to off-dock terminals, and mount charges for loading on-dock rail, or weighted averages of destination drays from rail ramps operated by different railroads.

As indicated above, many transportation rates are part of confidential contracts. For reasons of confidentiality, costs that are reported reflect the average of a basket of rates from multiple carriers rather than the specific rates of any particular contract or carrier. To further protect confidentiality, we report only total costs per cubic foot for each channel.

Domestic and marine vehicles have different cubic capacities. International cargo moves in 20-foot, 40-foot and 45-foot containers and has done so for many years. In contrast, the vehicles utilized for U.S. domestic freight have become progressively larger. Nowadays, the domestic truck fleet consists almost entirely of 53-foot trailers. Domestic containers and trailers used in rail intermodal service also have grown in size, from 40-foot trailers used in the early 1970s to 48-foot and 53-foot boxes today.

Domestic freight vehicles are not only longer than international containers, they are also taller and wider. The usable cubic space thus grows faster than the increment in length. Table 17 displays the useable cubic space of various vehicles. Note that a standard 53-

foot domestic container offers about 60% more useable space than a standard international 40-foot container; a 53-foot truck offers about 71% more useable space.

The vast majority of Asian imports are cube freight, in the sense that cubic capacities are reached before weight capacities are reached. To properly compare transportation costs, it is therefore necessary to express costs on a cost per cubic foot basis. For the purposes of this analysis, we have assumed shipments in 40-foot marine containers are 60% in high-cube 40-foot boxes and 40% in standard 40-foot boxes, leading to the weighted average cubic capacity shown in Table 17. Shipments trans-loaded into domestic containers for rail intermodal movements are assumed to utilize hi-cube 53-foot containers. For cube freight, this means the contents of five marine (40-foot) containers may be stuffed into three domestic (53-foot) trailers or high-cube containers.

Table 17. Space Capacities of Containers and Trucks

Vehicle Type	Usable Space for Lading (cubic feet)	Space as a % of Avg 40ft Space
20ft standard container	1,163	45.29%
40ft standard container	2,395	93.26%
40ft hi-cube container	2,684	104.52%
Wtd. Avg. 40ft container	2,568	100.00%
45ft standard container	3,026	117.83%
48ft standard container	3,471	135.16%
53ft standard container	3,830	149.14%
53ft hi-cube container	3,955	154.01%
53ft truck	4,090	159.27%

Note: The equipment specifications shown above represent those most commonly found in the industry. Actual specifications vary from carrier to carrier and across carrier fleets.

Transportation Unit Costs

Table 18 provides the estimated rates per cubic foot for shipment from Shanghai to the selected North American destinations via the alternative ports of entry listed above. It is assumed that freight shipped is cube freight, and that the cubic space of transportation vehicles is fully utilized. Not all port-destination pairs are shown; unreasonable combinations, such as Vancouver – Houston or New York – Dallas are omitted. All figures are expressed in dollars per cubic foot. The total transportation cost ranges from $1.40 up to $3.00 per cubic foot of vehicle capacity, depending on the destination, choice of port and choice of mode.

Table 18
Transportation Rates Per Cubic Foot,
Shanghai – Selected North American Destinations

Port of Entry	Destination Region	Direct Rail	Trans-load Rail Container	Direct Truck	Trans-load Truck	Direct Dray
Charleston	Atlanta	1.49	1.58	1.32	1.47	NA
Charleston	Baltimore	1.56	1.65	1.49	1.59	NA
Charleston	Boston	1.70	1.76	1.72	1.74	NA
Charleston	Charleston	NA	NA	NA	NA	1.22
Charleston	Charlotte	1.50	NA	1.27	1.44	NA
Charleston	Chicago	1.67	1.75	1.71	1.73	NA
Charleston	Cleveland	1.57	1.68	1.59	1.66	NA
Charleston	Columbus	1.55	1.66	1.54	1.62	NA
Charleston	Dallas	1.69	1.77	1.82	1.81	NA
Charleston	Harrisburg	1.62	1.49	1.58	1.65	NA
Charleston	Houston	1.68	1.71	1.79	1.79	NA
Charleston	Kansas City	1.66	1.77	1.83	1.81	NA
Charleston	Los Angeles	NA	NA	NA	NA	NA
Charleston	Memphis	1.60	1.69	1.57	1.64	NA
Charleston	Minneapolis	1.77	1.85	1.97	1.91	NA
Charleston	New York	1.64	1.71	1.62	1.67	NA
Charleston	Norfolk	1.52	1.65	1.41	1.54	NA
Charleston	Oakland	NA	NA	NA	NA	NA
Charleston	Pittsburgh	1.59	1.68	1.54	1.62	NA
Charleston	Savannah	NA	1.56	1.31	1.47	NA
Charleston	Seattle-Tacoma	NA	NA	NA	NA	NA
Charleston	Toronto	1.77	1.84	1.92	1.88	NA
Houston	Atlanta	1.62	1.68	1.62	1.67	NA
Houston	Baltimore	1.81	1.80	2.00	1.92	NA
Houston	Boston	1.96	1.89	2.26	2.09	NA
Houston	Charleston	1.68	1.72	1.78	1.78	NA
Houston	Charlotte	1.71	1.74	1.77	1.77	NA
Houston	Chicago	1.68	1.69	1.81	1.79	NA
Houston	Cleveland	1.74	1.73	1.95	1.89	NA
Houston	Columbus	1.71	1.71	1.86	1.83	NA
Houston	Dallas	1.47	1.58	1.28	1.45	NA
Houston	Harrisburg	1.84	1.83	2.06	1.96	NA
Houston	Houston	NA	NA	NA	NA	1.21
Houston	Kansas City	1.53	1.60	1.59	1.65	NA
Houston	Los Angeles	1.80	1.72	2.09	1.99	NA
Houston	Memphis	1.53	1.61	1.48	1.58	NA
Houston	Minneapolis	1.68	1.70	1.86	1.83	NA
Houston	New York	1.89	1.85	2.13	2.01	NA
Houston	Norfolk	1.76	1.77	1.97	1.90	NA
Houston	Oakland	NA	NA	NA	NA	NA
Houston	Pittsburgh	1.79	1.79	1.98	1.91	NA
Houston	Savannah	1.65	1.69	1.77	1.77	NA
Houston	Seattle-Tacoma	NA	NA	NA	NA	NA

Houston	Toronto	1.87	1.82	2.14	2.02	NA
LA-Long Beach	Atlanta	1.69	1.69	2.34	2.12	NA
LA-Long Beach	Baltimore	1.81	1.75	2.62	2.31	NA
LA-Long Beach	Boston	1.92	1.81	2.88	2.48	NA
LA-Long Beach	Charleston	1.76	1.73	2.52	2.24	NA
LA-Long Beach	Charlotte	1.78	1.74	2.47	2.21	NA
LA-Long Beach	Chicago	1.58	1.63	2.25	2.06	NA
LA-Long Beach	Cleveland	1.63	1.67	2.46	2.20	NA
LA-Long Beach	Columbus	1.63	1.65	2.37	2.14	NA
LA-Long Beach	Dallas	1.48	1.58	1.85	1.79	NA
LA-Long Beach	Harrisburg	1.78	1.77	2.60	2.29	NA
LA-Long Beach	Houston	1.51	1.58	1.94	1.85	NA
LA-Long Beach	Kansas City	1.47	1.55	1.96	1.87	NA
LA-Long Beach	Los Angeles	NA	NA	NA	NA	1.06
LA-Long Beach	Memphis	1.61	1.62	2.10	1.96	NA
LA-Long Beach	Minneapolis	1.60	1.62	2.13	1.98	NA
LA-Long Beach	New York	1.87	1.78	2.71	2.37	NA
LA-Long Beach	Norfolk	1.80	1.75	2.65	2.33	NA
LA-Long Beach	Oakland	NA	NA	1.22	1.37	NA
LA-Long Beach	Pittsburgh	1.75	1.74	2.49	2.22	NA
LA-Long Beach	Savannah	1.72	1.71	2.49	2.22	NA
LA-Long Beach	Seattle-Tacoma	1.43	1.51	1.68	1.68	NA
LA-Long Beach	Toronto	1.75	1.70	2.59	2.29	NA
Norfolk	Atlanta	1.62	1.74	1.54	1.66	NA
Norfolk	Baltimore	1.54	1.68	1.33	1.53	NA
Norfolk	Boston	1.63	1.74	1.55	1.67	NA
Norfolk	Charleston	1.57	1.70	1.46	1.61	NA
Norfolk	Charlotte	1.58	1.67	1.38	1.56	NA
Norfolk	Chicago	1.69	1.81	1.73	1.79	NA
Norfolk	Cleveland	1.56	1.69	1.51	1.64	NA
Norfolk	Columbus	1.57	1.72	1.54	1.66	NA
Norfolk	Dallas	1.78	1.78	2.03	1.99	NA
Norfolk	Harrisburg	1.58	1.70	1.39	1.56	NA
Norfolk	Houston	1.77	1.94	2.03	1.99	NA
Norfolk	Kansas City	1.73	1.84	1.91	1.91	NA
Norfolk	Los Angeles	NA	NA	NA	NA	NA
Norfolk	Memphis	1.70	1.82	1.74	1.80	NA
Norfolk	Minneapolis	1.78	1.89	1.95	1.94	NA
Norfolk	New York	1.61	1.71	1.42	1.58	NA
Norfolk	Norfolk	NA	NA	NA	NA	1.28
Norfolk	Oakland	NA	NA	NA	NA	NA
Norfolk	Pittsburgh	1.59	1.70	1.45	1.61	NA
Norfolk	Savannah	1.62	1.73	1.64	1.73	NA
Norfolk	Seattle-Tacoma	NA	NA	NA	NA	NA
Norfolk	Toronto	1.70	1.78	1.72	1.79	NA
NY-NJ	Atlanta	1.70	1.85	1.75	1.84	NA
NY-NJ	Baltimore	NA	NA	1.33	1.56	NA
NY-NJ	Boston	NA	NA	1.35	1.58	NA
NY-NJ	Charleston	1.67	1.82	1.70	1.81	NA
NY-NJ	Charlotte	1.66	1.82	1.62	1.76	NA

NY-NJ	Chicago	1.66	1.79	1.71	1.82	NA
NY-NJ	Cleveland	1.58	1.74	1.50	1.68	NA
NY-NJ	Columbus	1.59	1.74	1.55	1.71	NA
NY-NJ	Dallas	1.82	1.94	2.19	2.14	NA
NY-NJ	Harrisburg	NA	NA	1.26	1.52	NA
NY-NJ	Houston	1.87	1.95	2.22	2.16	NA
NY-NJ	Kansas City	1.72	1.86	1.98	2.00	NA
NY-NJ	Los Angeles	NA	NA	NA	NA	NA
NY-NJ	Memphis	1.69	1.83	1.90	1.95	NA
NY-NJ	Minneapolis	1.66	1.81	1.98	2.00	NA
NY-NJ	New York	NA	NA	NA	NA	1.33
NY-NJ	Norfolk	1.55	1.74	1.45	1.64	NA
NY-NJ	Oakland	NA	NA	NA	NA	NA
NY-NJ	Pittsburgh	1.57	1.76	1.44	1.64	NA
NY-NJ	Savannah	1.70	1.85	1.87	1.92	NA
NY-NJ	Seattle-Tacoma	NA	NA	NA	NA	NA
NY-NJ	Toronto	1.59	1.76	1.52	1.69	NA
Oakland	Atlanta	1.75	1.74	2.49	2.26	NA
Oakland	Baltimore	1.86	1.79	2.70	2.40	NA
Oakland	Boston	1.93	1.85	2.90	2.54	NA
Oakland	Charleston	1.81	1.78	2.71	2.41	NA
Oakland	Charlotte	1.84	1.80	2.64	2.36	NA
Oakland	Chicago	1.63	1.68	2.29	2.13	NA
Oakland	Cleveland	1.68	1.71	2.49	2.26	NA
Oakland	Columbus	1.70	1.68	2.46	2.24	NA
Oakland	Dallas	1.50	1.61	2.03	1.96	NA
Oakland	Harrisburg	1.85	1.80	2.67	2.38	NA
Oakland	Houston	1.55	1.63	2.15	2.04	NA
Oakland	Kansas City	1.51	1.58	2.10	2.01	NA
Oakland	Los Angeles	NA	NA	1.20	1.40	NA
Oakland	Memphis	1.64	1.66	2.26	2.11	NA
Oakland	Minneapolis	1.67	1.67	2.23	2.09	NA
Oakland	New York	1.92	1.82	2.77	2.45	NA
Oakland	Norfolk	1.87	1.81	2.82	2.49	NA
Oakland	Oakland	NA	NA	NA	NA	1.09
Oakland	Pittsburgh	1.83	1.78	2.56	2.31	NA
Oakland	Savannah	1.79	1.77	2.64	2.36	NA
Oakland	Seattle-Tacoma	NA	NA	1.46	1.58	NA
Oakland	Toronto	1.83	1.77	2.63	2.36	NA
Savannah	Atlanta	1.48	1.58	1.29	1.45	NA
Savannah	Baltimore	1.63	1.73	1.67	1.71	NA
Savannah	Boston	1.77	1.86	1.95	1.90	NA
Savannah	Charleston	NA	NA	1.31	1.47	NA
Savannah	Charlotte	1.50	1.60	1.29	1.46	NA
Savannah	Chicago	1.66	1.75	1.73	1.75	NA
Savannah	Cleveland	1.56	1.69	1.62	1.67	NA
Savannah	Columbus	1.56	1.68	1.59	1.65	NA
Savannah	Dallas	1.68	1.76	1.78	1.78	NA
Savannah	Harrisburg	1.61	1.70	1.59	1.66	NA
Savannah	Houston	1.68	1.75	1.78	1.78	NA

Savannah	Kansas City	1.63	1.74	1.79	1.79	NA
Savannah	Los Angeles	NA	NA	NA	NA	NA
Savannah	Memphis	1.57	1.68	1.56	1.63	NA
Savannah	Minneapolis	1.75	1.85	1.99	1.92	NA
Savannah	New York	1.70	1.79	1.79	1.79	NA
Savannah	Norfolk	1.56	1.68	1.59	1.65	NA
Savannah	Oakland	NA	NA	NA	NA	NA
Savannah	Pittsburgh	1.60	1.70	1.60	1.66	NA
Savannah	Savannah	NA	NA	NA	NA	1.22
Savannah	Seattle-Tacoma	NA	NA	NA	NA	NA
Savannah	Toronto	1.82	1.92	2.10	1.99	NA
Seattle-Tacoma	Atlanta	1.69	1.68	2.63	2.28	NA
Seattle-Tacoma	Baltimore	1.80	1.73	2.68	2.32	NA
Seattle-Tacoma	Boston	1.90	1.78	2.85	2.43	NA
Seattle-Tacoma	Charleston	1.78	1.71	2.78	2.38	NA
Seattle-Tacoma	Charlotte	1.80	1.73	2.74	2.36	NA
Seattle-Tacoma	Chicago	1.57	1.60	2.24	2.02	NA
Seattle-Tacoma	Cleveland	1.64	1.63	2.44	2.16	NA
Seattle-Tacoma	Columbus	1.64	1.60	2.42	2.15	NA
Seattle-Tacoma	Dallas	1.50	1.56	2.29	2.06	NA
Seattle-Tacoma	Harrisburg	1.80	1.73	2.63	2.28	NA
Seattle-Tacoma	Houston	1.58	1.56	2.47	2.18	NA
Seattle-Tacoma	Kansas City	1.45	1.53	2.12	1.94	NA
Seattle-Tacoma	Los Angeles	1.41	1.46	1.66	1.64	NA
Seattle-Tacoma	Memphis	1.59	1.60	2.41	2.14	NA
Seattle-Tacoma	Minneapolis	1.44	1.51	1.99	1.86	NA
Seattle-Tacoma	New York	1.85	1.75	2.73	2.35	NA
Seattle-Tacoma	Norfolk	1.81	1.73	2.75	2.37	NA
Seattle-Tacoma	Oakland	NA	NA	1.46	1.50	NA
Seattle-Tacoma	Pittsburgh	1.75	1.71	2.53	2.22	NA
Seattle-Tacoma	Savannah	1.75	1.69	2.78	2.38	NA
Seattle-Tacoma	Seattle-Tacoma	NA	NA	NA	NA	1.02
Seattle-Tacoma	Toronto	1.69	1.65	2.57	2.25	NA
Vancouver, BC	Atlanta	1.75	1.77	2.70	2.36	NA
Vancouver, BC	Baltimore	1.79	1.78	2.75	2.39	NA
Vancouver, BC	Boston	1.89	1.83	2.93	2.51	NA
Vancouver, BC	Charleston	1.83	1.79	2.85	2.46	NA
Vancouver, BC	Charlotte	1.86	1.81	2.82	2.43	NA
Vancouver, BC	Chicago	1.60	1.63	2.31	2.10	NA
Vancouver, BC	Cleveland	1.66	1.70	2.52	2.23	NA
Vancouver, BC	Columbus	1.67	1.71	2.50	2.22	NA
Vancouver, BC	Dallas	1.66	1.69	2.36	2.13	NA
Vancouver, BC	Harrisburg	1.79	1.78	2.70	2.36	NA
Vancouver, BC	Houston	1.71	1.72	2.55	2.25	NA
Vancouver, BC	Kansas City	1.56	1.66	2.19	2.02	NA
Vancouver, BC	Los Angeles	NA	NA	1.73	1.71	NA
Vancouver, BC	Memphis	1.64	1.70	2.49	2.21	NA
Vancouver, BC	Minneapolis	1.48	1.57	2.06	1.93	NA
Vancouver, BC	New York	1.85	1.79	2.80	2.42	NA
Vancouver, BC	Norfolk	1.81	1.78	2.83	2.44	NA

Vancouver, BC	Oakland	NA	NA	1.53	1.58	NA
Vancouver, BC	Pittsburgh	1.75	1.75	2.60	2.29	NA
Vancouver, BC	Savannah	1.81	1.78	2.85	2.46	NA
Vancouver, BC	Seattle-Tacoma	NA	NA	1.03	1.24	NA
Vancouver, BC	Toronto	1.62	1.66	2.65	2.32	NA

Transportation Cost Comparison

As may be seen in Table 18, overall handling and transportation costs to trans-load to 53-foot containers are not much more from West Coast ports than total costs for direct rail movement in marine containers and sometimes even less, generally ranging ($0.02) - $0.05 per cubic foot more. For reverse intermodal movements from East Coast ports, overall handling and transportation costs to trans-load to 53-foot containers generally range $0.07 - $0.15 per cubic foot more than that for direct rail movement of marine containers. Direct truck and Trans-load truck also are comparable with each other. Both types of truck movements generally range $0.40 - $0.60 more per cubic foot than that for direct rail movement from West Coast ports, and generally range $0.05 - $0.15 more per cubic foot that that for direct rail movement from East Coast ports. Short-haul truck is sometimes comparable or even less than rail.

These comparisons set the stage for the overall economic allocation of imports to channels. As will be shown, low-value goods are most cheaply handled in the direct channels. Moderate-value and high-value goods that are shipped in enough volumes and distributed over wide enough areas to be amenable to transloading are more cheaply handled in the trans-loading channels.

Transloading vs. Direct Shipment

The opportunity at de-consolidation to trans-load into the larger domestic vehicles enables importers to partially defray the added expenses of the side trip to a de-consolidation warehouse in the hinterland of the port of entry. That is, the reduction in line haul transportation costs (per cubic foot of cargo) partially offsets the added costs associated with one extra lift and two extra drays, the costs for the transloading/deconsolidation activity itself, and the increment in pipeline inventory.

While there are some heavy cargoes in Asia – U.S. trade such as imported steel, it is our impression that the vast majority of containerized imports consist of relatively light cargoes that reach space limits before reaching weight limits. We estimate typically 48 hours (two days) is lost for cargo that is to be immediately de-consolidated and trans-loaded to domestic containers or trucks. Thus transloading entails up to two additional days of pipeline inventory for the importer and corresponding additional inventory carrying costs.[24] At the same time, the opportunity for mixing and reallocation of cargoes

[24] Domestic stack train schedules are often faster than marine stack train schedules. The overall increment in pipeline inventory is less than two days in some lanes.

at a transloading warehouse in the port of entry hinterland offers the opportunity to reduce safety stocks at destinations with corresponding reductions in inventory carrying costs, as analyzed above.

Thus deconsolidation/transloading vs. direct shipping is a trade-off between added transportation expenses and reduced inventory expenses. As will be discussed in Chapter 7, a certain minimum volume and a nation-wide fleet of RDCs are required for an importer to potentially benefit from the transloading strategy. Among those with such a scale and scope, it turns out that for low-value goods the transloading strategy does not pay. For moderate-value and high-value goods, it pays off.

Growth of the Domestic Container Fleet

The feasibility of the transloading strategy depends upon an adequate supply of domestic vehicles. Tracing the growth and mix of domestic intermodal container fleet over the last several years, we are able to confirm a substantial increase in the supply of 53-foot containers. Table 19 documents this growth. In 1998, only 14% of the domestic container fleet consisted of 53-foot boxes. But by 2002, 53-foot boxes accounted for almost half of the fleet. Considering expiration dates of current leases and anticipated retirements, we project that by 2007 more than 85% of the fleet will consist of 53-foot boxes.

These figures confirm that the supply of 53-foot domestic containers became adequate in recent years to support the West Coast distribution warehousing and transloading strategies pursued by large importers in recent years. Considering that the fleet size of 53-foot containers will continue to grow, we expect continued growth in transloading volumes.

An important point concerning transloading is that Southern California is by far the largest West Coast market for inbound domestic freight. It would be more difficult for the Bay Area, Seattle/Tacoma or Vancouver to develop transloading traffic to the extent that has happened in Southern California, simply because the supply of domestic 53-foot containers is smaller (reflecting the smaller amounts of westbound domestic freight traffic). To the extent that West Coast distribution and transloading is economically attractive to importers of Asian-manufactured goods, the SPB Ports have a competitive advantage for this traffic, owing to Southern California's more generous supply of 53-foot containers. Nonetheless, as the fleet size of 53-foot containers enlarges, we anticipate the levels of transloading activity at other West Coast ports to increase.

Table 19
Domestic Container Fleet, 1998 to 2007

	1998	2000	2002	2007 Projected
48 foot	76,112	77,670	65,124	24,045
53 foot	12,500	34,758	56,686	138,436
Total	**88,612**	**112,428**	**121,810**	**162,481**
53ft % of total	***14.1%***	***30.9%***	***46.5%***	***85.2%***

	48 foot Containers			53 foot Containers		
Carrier	**1998**	**2000**	**2002**	**1998**	**2000**	**2002**
UP	11152	12823	11723	0	6436	8936
BNSF	16000	16000	13500	0	1500	4004
NS	6020	6004	5800	0	4997	4921
CSX	6550	6498	8030	0	0	4750
CP	5200	5100	5100	0	1000	2600
CN	4600	4550	4500	0	500	1400
KCS	1050	1045	1496	0	100	100
PACER SS	17990	17950	13000	0	5725	9200
JB HUNT	7550	7500	1500	12500	14500	20500
TFM	0	200	475	0	0	0
FXE	0	0	0	0	0	275
TOTAL	**76,112**	**77,670**	**65,124**	**12,500**	**34,758**	**56,686**

Note: Some small operators with fleets of less than 500 units may have been omitted.
Some carriers contribute to pools (e.g., NACS, EMP). Ownership shown here by carrier.

7. INTANGIBLE FACTORS

In Chapter 8 we introduce a Long-Run Elasticity Model that calculates allocations of Asian imports to ports and supply channels based on the economics of transportation and inventory from the importers' point of view. There are a number of important intangible factors not incorporated in the quantitative analyses of the Model, summarized as follows.

Port Terminals as Virtual Warehouses

Some importers deliberately delay pick-up of containers from port terminals. If demand at destination has slowed compared to forecasts made when the goods were ordered, and so the goods in the container are not yet needed, such importers use the port terminal as a virtual warehouse. Certain very large importers have negotiated with the steamship lines for very large amounts of free time[25] for their containers awaiting dray pick-up at the port terminals.

This has several effects. First, this creates greater opportunity for trans-loading importers to re-direct imported goods where they are most needed, thereby reducing safety stock requirements at destination distribution centers. This enhances the value of the trans-loading channel in a way that is not included in the formulas developed in Chapter 5.[26] Second, it increases congestion and decreases throughput at port terminals. More acreage is required as the terminal has in effect been converted into a virtual import warehouse. Third, the steamship lines observe that the average dwell time at port terminals for "store-door" (i.e., local and trans-load) import boxes is much larger than for inland-point intermodal boxes. In order to maximize box utilization, they tend to prioritize inland point intermodal boxes in the way they stow cargo on their vessels and the way they unload the vessels. This has the result that the average transit time from vessel arrival to rail interchange for the Direct Rail channel (AKA inland point intermodal) is one to three days less than the average transit time from vessel arrival to local warehouse delivery for boxes moving in the Trans-load channels. This is ironic, in that shippers of high-value goods, for whom managing inventories tightly is most important, are allocated the longest lead times.

Diversification of Congestion Risk

During the summer of 2004, serious congestion (which the industry press – and many customers – termed a "meltdown") was experienced at the San Pedro Bay Ports. Many vessels were greatly delayed from unloading, and unloaded containers were further delayed awaiting dray or rail pick-up because of shortages of staff and equipment. In interviews with 3PL firms and carriers, we were advised that many shippers were unable to divert substantial cargoes to other ports, as they did not have adequate redundancy engineered into their logistics systems. We are advised there is now widespread recognition among importers of the need to diversify their logistics strategy, to have alternatives readily available in case a meltdown develops in one particular shipping channel or at one particular port. We have received considerable anecdotal evidence that shippers have increased their arrangements for transloading services at ports other than San Pedro Bay.

To the extent that importers divert traffic purely for the purpose of diversifying the port channels utilized, this factor suggests the Long-Run Elasticity Model may be too high in its predictions of volume through the SPB Ports.

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[25] Reportedly, 21 days in one case.

[26] The same is true if the importer implements a port-hinterland warehouse (as opposed to merely deconsolidating and immediately cross-docking and re-shipping all imports).

Other Cost Factors

Third-party logistics firms providing transloading services to importers sometimes are hired to perform other services besides sorting-by-destination and transloading the imported goods. Commonly provided outbound distribution services include piece-count and/or manifest verification by SKU (stock-keeping unit), and attaching bar codes. Other services sometimes provided include stretch-wrapping or palletization, and, much less often, short-term storage.

We are advised by 3PL firms that the vast majority of containerized imports from Asia are simply floor-loaded in the container. All of the above types of tasks need to be completed before the goods may be handled through mechanized regional distribution centers. That is, piece-counts must be made, the goods need to be stretch-wrapped, and bar codes need to be attached. If these activities were not done at the transloading warehouse in the port hinterland, they would have to be done upon arrival at the inland regional distribution center itself or else at a mixing center in Asia before sea shipment. Stretch-wrapping in Asia would entail a loss of usable cubic capacity in the container. If labor costs at inland distribution centers are higher than at the port hinterland warehouses, there is an economic incentive to perform these activities in the port hinterland.

These factors may enhance the attractiveness of the trans-loading option compared to the cost calculations made using the formulas developed in Chapter 5.

Regional Importers

In the Long-Run Elasticity Model we assume the top 83 Asian importers are nation-wide in the scope of their distribution operations. If any are regional in nature, their eligibility for trans-loading may be sharply curtailed compared to the assumptions of the Model.

The Model also assumes that "generic" importers that account for the rest of Asia – U.S. imports are not eligible for trans-loading (because they are too small or too regional). Moreover, it is assumed that, in aggregate, for all levels of declared value, the geographical dispersion of their destinations is proportional to the geographic dispersion of purchasing power in the United States.

If any of the "generic" importers actually practice trans-loading, the Model misses this. If in aggregate the destinations of generic importers are distributed differently from the distribution of purchasing power, the Model misses this, too.

Taken together, these factors are off-setting and do not suggest a major bias in Model calculations.

Short Run Vs. Long Run Factors

The Long-Run Elasticity Model exercised in Chapter 8 analyzes given transportation rates, values of goods, and transit time statistics faced by importers to determine the least costly allocation of imports to ports and channels. Transit time statistics are exogenously supplied to the model and are not updated if the Model shifts substantial traffic volumes between ports or modes. The Model results should be interpreted as indicating the fee levels at which importers would experience an economic incentive to reduce import volumes through the SPB Ports.

In the short run, there are many factors inhibiting the shifting of imports to other ports or alternative channels. There are multiple dimensions of capacity constraining channel volumes. Moreover, steamship lines may be committed to relatively long-term port contracts whose fee structures provide the incentive for the lines to tender large volumes and mandate stiff penalties for premature withdrawal. Given a scenario in which there is economic incentive for importers to shift their import volumes between modes or between ports, there will be inertia inhibiting such shifts. Major shifts in import traffic may require considerable time to implement. In the short run, San Pedro Bay Ports traffic will be significantly more inelastic than predictions derived using the Long-Run Model. Notwithstanding these factors, given strong economic incentives for importers to shift traffic, one may expect *in the long run* that desired terminal and line haul capacities will get built, new port contracts will be negotiated, vessel strings will be adjusted, new trans-loading warehouses will be erected, and dray forces will be adjusted. For that reason, the evaluation of potential major investments in ports access infrastructure, requiring many years to construct and many more years to recoup the investment, is best done considering the long-run elasticity of port demand.

Nonetheless, the short-run evolution of ports traffic is of considerable interest. The most prominent short-run factors inhibiting the shifting of port and channel volumes in the short run are therefore discussed in more detail below.

Capacity and Congestion

The Long-Run Elasticity Model described in Chapter 8 does not include any capacity constraints. Imports are assigned to channels based on minimization of the importers' costs – including transportation charges in each channel, and inventory costs resulting from the pre-specified transit times and opportunities for consolidation/deconsolidation.

Transit time parameters used in Model calculations are exogenously supplied by the user and remain fixed during the Model's calculations. In reality, the mean and standard deviation of transit time both increase dramatically as utilization of a channel is increased to high percentages of its capacity. (What happened in the summer of 2004 at the SPB Ports is an obvious case in point.) Moreover, it is likely that service providers using congested channels may be motivated to increase their charges or curtail service.

Most North American ports are operating close to their current capacities during peak shipping season. If there were to be massive diversion of traffic away from the SPB

Ports, it is doubtful this traffic could be accommodated without substantial infrastructure investments in other port regions.

In the analysis of current traffic volumes and current costs, the Elasticity Model predicts feasible allocations of imports to channels. In analyzing scenarios with marginal changes in costs or volumes, the Model can be expected to provide reasonable predictions of short-run behavior. At issue is the analysis of scenarios with added costs (e.g., container fees) that entail a major departure from current costs. The Model's traffic calculations in that case may be very inconsistent with the existing available capacity. Moreover, transportation rates are likely to change in such a scenario.

Thus in cases where the Long-Run Elasticity Model responds to strong economic incentive by calculating major traffic shifts, there is the question of whether sufficient capacity exists (or can be created) to allow such a shift. The interpretation of Long-Run Elasticity Model results for scenarios very different from current economics must therefore be tempered.

There are numerous examples of this, some discussed below.

Panama Canal

The Panama Canal is an example of a capacity-constrained channel. The Canal is reported to be operating very close to capacity. Importers report that securing space on vessel strings transiting the Canal is becoming increasingly difficult.

In some scenarios it could be called upon to analyze, the Long-Run Elasticity Model's calculations may call for higher levels of utilization of the Canal, perhaps even infeasible volume levels through the Canal.

One might expect that if there is very strong demand for increased Canal capacity, investment in its expansion would follow. But this takes time. In 2005, the Government of Panama was planning to hold a referendum among the populace asking whether or not the Country should build a third set of locks – and supply the water necessary to operate them – in order to accommodate post-Panamax vessels, a multi-billion-dollar undertaking. But later in 2005 the referendum plans were tabled by the Government. Even if approved, it is estimated that a decade or more would be required to complete the project.

Larger Vessels

Another aspect of the Panama Canal capacity issue is the fleet mix of the steamship lines. Some lines are investing heavily in post-Panamax vessels with capacities on the order of 10,000 TEUs. A number of lines already operate 8,000 TEU vessels. Such large vessels are confined to service in Asia – Europe or Trans-Pacific lanes. While the introduction of such vessels displaces older Panamax vessels that can be re-deployed in strings passing through the Panama Canal, the overall fleet capacity has a declining fraction that is eligible for that type of service.

Deconsolidation Capacity

The consultant has heard estimates to the effect that, considering the total warehouse capacity suitable for deconsolidation activity in the hinterlands of all North American ports of entry, 65% is located in Southern California. Displacing a large fraction of the trans-loading activity in Southern California is simply not feasible without more investment in warehouse capacity in other port regions. How “large” is infeasible is at present not quantified. By how much trans-loading capacities can be increased (and at what cost) at the various ports is at present not quantified.

Port Capacities

Capacities at ports are multi-dimensional. One aspect of capacity concerns dock labor to unload and re-load vessels and transfer containers onto chasses and rail well cars. Another aspect concerns the supply of dray labor to haul boxes from the port gate to off-dock rail terminals and warehouses in the region. A third aspect concerns the ability of rail terminals and rail lines to handle increased traffic.

All of these aspects of capacity were severely strained in 2004 peak season in Southern California. Many shippers responded by shifting some of their 2005 import volume to Seattle-Tacoma and, to a lesser extent, to Oakland. Stakeholders are concerned that a back-up could develop up north akin to what happened in Southern California in 2004.

A Long-Run Elasticity Model calculation that calls for a large shift of volume from one port to another must be judged in light of the multi-dimensional capacity of that port.

Productivity Differences Among Ports

Throughput rates (measured in lifts per hour or TEUs per acre or vessel moves per quay foot) vary among ports. Certain East Coast ports exhibit better numbers than West Coast ports. Certain Asian ports exhibit number even better than the best US East Coast ports.

Where a port lags the performance of others, this suggests there is an opportunity to improve and thereby increase capacity. Improvements may involve labor issues, technology or both. Thus capacity at the ports is a moving target.

There is a chicken-and-egg phenomenon here: The incentive to improve productivity increases dramatically as the volume is increased. Thus current “capacity” limits at each port might not be the real limits. Instead, as volumes are pushed towards those limits, efforts to improve productivity will accelerate and “capacity” will be increased.

Vessel Operator-Port Contracts and Other Inertia

Steamship lines enter into long-term contracts with ports. The rents are a function of volume; generally, the lines have an economic incentive to sustain high volume at the port (thereby decreasing the port charges per container). A Long-Run Elasticity Model calculation that calls for a large shift of volume from one port to another must be judged in light of the contractual disincentive.

Many importers enter into contracts with steamship lines. These contracts often entail volume commitments by origin – destination pair. Once an economic incentive exists for an importer to switch from direct shipping to inland points to trans-loading in the hinterland of the port of entry, such contracts may delay or impede the transition.

Every importer must make considerable effort to develop a supply-chain management system. A Model calculation that calls for major shifts in supply-chain strategy (e.g., switch from trans-load to direct-ship) may in turn trigger the need for re-engineering the supply-chain management system. Thus there may be some inertia or time lag on the part of importers to change their supply-chain strategy, even when economic incentive exists to do so.

Container Repositioning Surcharges

Traditionally, merchandise traffic in lanes between central or eastern US points on the east end and West Coast points at the west end was heavier westbound than eastbound. (Westbound traffic was termed the "headhaul" and eastbound traffic was termed the "backhaul".)

The growth in Asian imports has changed that; eastbound traffic is now greater, much greater during peak shipping season. There is considerable upward pressure on eastbound rates for domestic containers and trailers, especially during peak shipping seasons. As a result, in some lanes at certain times of the year, equipment repositioning surcharges are being assessed.

Similarly, there is upward pressure on rates for direct inland movement of marine containers. At present, as a rough average, there is one export load for every three-to-four import loads. Most marine containers moved to inland points are returned to the ports empty. This average is declining, and in certain lanes the steamship lines are applying surcharges to inland point intermodal rates because of the dearth of backhaul business in those lanes.

A Long-Run Elasticity Model calculation that predicts either a large increase in trans-loading or a large increase in direct inland point movement of marine containers must be interpreted with caution. A large swing in the relative demands for domestic vs. marine containers would likely entail a commensurate change in the relative re-positioning charges for those types of equipment. Transportation rates input to the Model may require adjustment.

8. ELASTICITY CALCULATIONS

Modeling Procedure

The transportation costs developed in Chapter 6 and the inventory cost formulas developed in Chapter 5 were combined to compute total costs for importers. The 83 major importers listed in Table 12 were subjected to these calculations. We assume each importer applies a single homogenous supply-chain strategy to handle all of its imported goods at the least overall cost for the assumed average declared value of its imports (as specified in Table 12). The importer's total assumed volume (also shown in Table 12) was allocated among the destination regions defined in Chapter 7 in proportion to the purchasing power in each region (Table 16).

To account for the remaining import volume, a set of "proxy miscellaneous" importer categories were generated, not eligible for transloading, stratified along the value distribution of Figure 8 in value increments of $4 per cubic foot from a low of $2 to a high of $70.[27] The relative volumes in each value category are displayed in Table 20.

Table 20
Assumed Distribution of Import Volumes by Declared Values
for Proxy Miscellaneous Importers

Declared Value Per Cubic Foot	Fraction of Total Misc. Imports	Declared Value Per Cubic Foot	Fraction of Total Misc. Imports
$2	0.002	$38	0.050
$6	0.021	$42	0.040
$10	0.185	$46	0.022
$14	0.153	$48	0.018
$18	0.128	$50	0.014
$22	0.107	$54	0.016
$26	0.089	$58	0.010
$30	0.074	$62	0.005
$34	0.061	$66	0.003
		$70	0.002

[27] An extra increment at $50 was made because of a major break-point in shipping economics near this value.

The total amount of proxy miscellaneous imports was calibrated so that sum of proxy miscellaneous imports and major-shipper imports added to the total 2004 imports from Asia to the USA. The volumes for each proxy miscellaneous value category also were allocated to destination regions in proportion to the purchasing power in each region (as defined in Table 16).

The As-Is Scenario

For each importer, total costs for alternative strategies were computed to deduce the least-cost strategy for each type of importer. The alternative strategies so tested are as follows:

- Direct shipping via nearest port to each region
- Direct shipping via least-cost West Coast ports to each region (least cost considering all transportation and inventory costs)
- Trans-load only at LA – Long Beach, then least-cost shipping
- Trans-load Los Angeles Region imports at LA – Long Beach, but trans-load everything else at Seattle-Tacoma, then least-cost shipping
- Trans-load only at Seattle-Tacoma, then least-cost shipping
- Trans-load only at Oakland, then least-cost shipping
- Trans-load only at Seattle/Tacoma and LA – Long Beach, then least-cost shipping
- Trans-load at Seattle/Tacoma, LA – Long Beach and Norfolk, then least-cost shipping
- Trans-load at Seattle/Tacoma, LA – Long Beach, Savannah and New York, then least-cost shipping

Total costs were tallied for each alternative strategy for each importer and the best strategy identified. For major importers, the break points in value and the corresponding optimal supply-chain strategy were found to be as summarized in Table 21.

Table 21
Efficient Supply-Chain Strategies as a Function of Avg. Declared Value for Large Nation-Wide Importers – As-Is Scenario

Value Range ($ per cu ft)	**Strategy**
0 – 13	Direct shipping using nearest port
13 – 27	Trans-load at multiple West Coast ports
27 and up	Trans-load only at LA – Long Beach

For the proxy generic importers (those lacking the scale and/or scope for transloading), the optimal supply-chain strategies were found to be as summarized in Table 22.

Table 22
Efficient Supply-Chain Strategies as a Function of Avg. Declared Value for Regional and Small-Scale Importers – As-Is Scenario

Value Range ($ per cu ft)	Strategy
0 – 46	Direct shipping using nearest port
46 and up	Direct shipping using least-cost West Coast ports

This analysis was repeated with the addition of a variable container fee assessed on all containers entering through the ports of Los Angeles and Long Beach. Fee values expressed in increments of $30 per 40-foot container ranging from $0 to $1,200 were tested. The direct and trans-load volumes via LA-Long Beach were then totaled for each fee value in order to construct curves of volume vs. container fee.

As the value of the fee was increased from zero, certain importers would be induced to change strategies in order to minimize total cost. For example, trans-load importers might be induced to shift trans-loading to other West Coast ports or open up trans-load centers at East Coast ports. Direct shippers might be induced to ship solely using other ports.

As a concrete example, consider a trans-load importer with an average declared value of $17.50 per cubic foot. The optimal policy for fee values between $0 and $320 is to trans-load at both LA-Long Beach and Seattle-Tacoma. For fee values between $320 and $361, the optimal policy is to trans-load at Los Angeles, Seattle-Tacoma, Savannah and New York – New Jersey. For a fee at LA – Long Beach between $361 and $567, the optimal policy is to utilize LA-Long Beach for local cargoes only, with trans-loading of cargoes for other areas handled at the other three ports of entry. For fees above $567, the optimal policy is to divert all Los Angeles Region cargo to Oakland and truck it from there.

As another concrete example, consider a direct shipper with an average declared value of $50 per cubic foot. For fees in the range of $0 to $72, the optimal policy is to direct ship from the least-cost West Coast port. For fees in the range $72 to $396, only traffic local to the Los Angeles Region is routed through the LA – Long Beach ports. For fees greater than $396, the LA – Long Beach ports are abandoned entirely, and Los Angeles Region volume is trucked down from Oakland.

Figure 10 displays the elasticity results for the case of current transit time values (the "As-Is" Scenario). This can be construed to represent the case where container fees are assessed but are not used to pay for improvements to the ports and port access infrastructure. Shown are curves for the total LA – Long Beach inbound container volume (in FEUs) as well as the portion of inbound volume that passes through deconsolidation warehouses (i.e., trans-load volume). The elasticity curves are somewhat "lumpy" because so many importers share the same average declared value of imports and so it is optimal for many of them to reduce LA – Long Beach volumes at the same point on the fee scale.

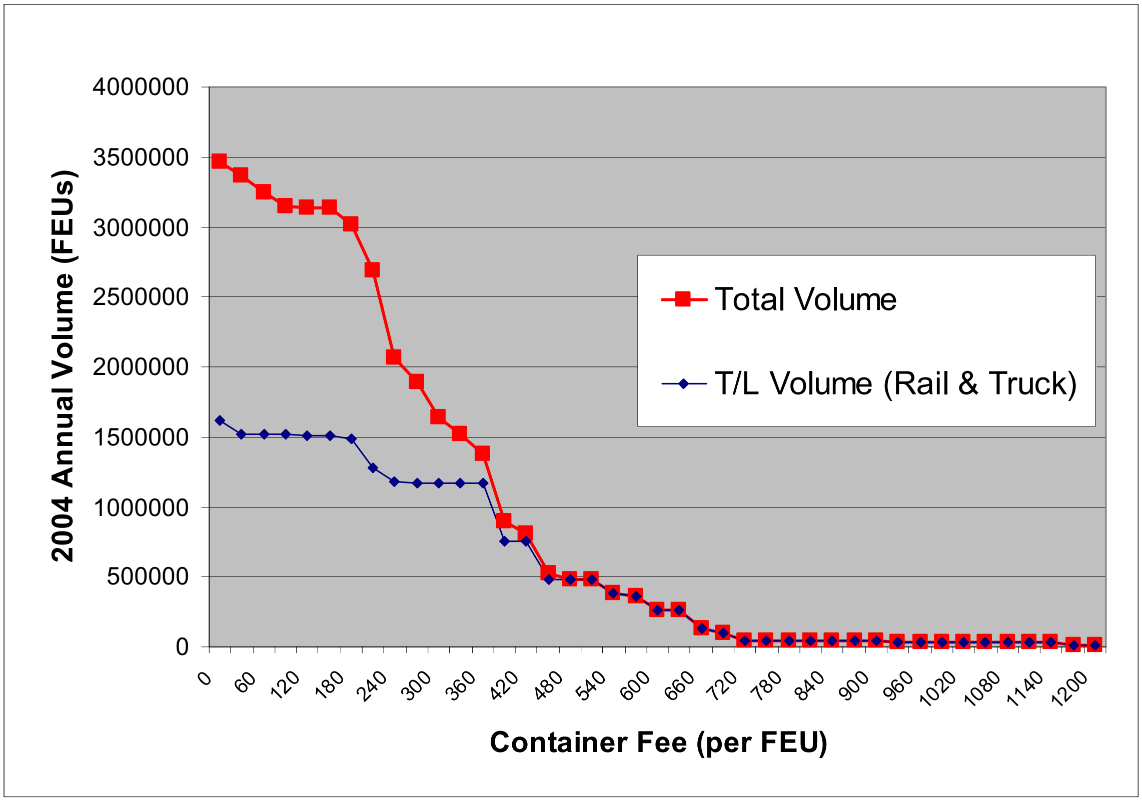

Figure 10.
Elasticity of Imports via the San Pedro Bay Ports, As-Is Scenario

The model predicts that, at present, about 46% of imports through the SPB Ports pass through deconsolidation centers. At first glance, this figure may seem too high. But this figure includes not only imports destined to intermodal regions but also imports destined to points within the Los Angeles Region that are passed through deconsolidation centers. This is done so as to pool local forecast errors and transit time variability with those for other regions and thereby reduce safety stock levels at destination distribution centers. The model predicts about 37% of SPB imports are direct rail, 34% are trans-loaded imports re-shipped by truck or rail outside the Los Angeles Region, 12% are trans-loaded imports consumed within the Los Angeles Region, and 17% are direct truck or local direct dray.

As may be seen, imports at SPB Ports are fairly inelastic until fees in the range of $180 are introduced. At that point, total volume has declined about 13% and trans-load volume has declined about 8%. Note that trans-loading traffic is much more inelastic to container fees than is direct shipping: For fees increasing from $180, the analysis predicts steep declines in total container volumes through the SPB Ports, but trans-load volumes hold up much better until fees above $360 are encountered, at which point they too begin steep declines.

As a reference point, the Lowenthal bill proposes a $30 per TEU (i.e., $60 per FEU) container fee without earmarking funds for any specific program of infrastructure improvement. From Figure 10 we see that the elasticity model predicts a 6.3% drop in imports through the SPB Ports as a result of this fee, provided no improvements to port access infrastructure are made that reduce transit times. Trans-loaded imports are predicted to decline 5.9% for such a fee.

The Congestion Relief Scenario

A different scenario was developed in which certain lead time parameters at only the SPB Ports were reduced. In particular, the mean transit time from port to trans-load warehouses was reduced from 3 days to 2 days, and the standard deviation of this transit time was reduced from 2 to 1.6 days. In addition, the standard deviations of rail transit times for movements out of the LA Basin were reduced by 0.1 days, with that for rail movement of marine containers dropping from 3 to 2.9 days and that for rail movement of domestic containers dropping from 1 to 0.9 days. We term this the "Congestion Relief" Scenario.

This scenario represents the case where proceeds from the assessment of container fees are used to retire the bonds on major port access infrastructure improvements, including dedicated truck lanes from the ports to the warehouse district and rail capacity and terminal improvements permitting more reliable service. The modeled reductions in the port-to-warehouse dray transit time mean and standard deviation are justified as follows: At present, dray operations for "store-door" traffic typically start on the third day after vessel arrival and complete on the fifth day. (Drays to rail intermodal ramps are completed beforehand.) It is assumed that dedicated truck lanes from the port to the warehouse district would be constructed, enabling "double-bottom" drays (two containers/chassis per dray). This infrastructure would substantially reduce this duration; the consultant estimates the mean would drop by one day and the standard deviation would drop by 0.4 days. Moreover, a major program of capacity improvements to main lines in Southern California plus the addition of substantial new rail terminal capacity should serve to improve the reliability of rail services. The consultant estimates the reduction in standard deviation of rail transit times from the Los Angeles Basin afforded by such improvements to be 0.1 days.[28]

The Congestion Relief Scenario significantly changes the economics for importers. Assuming no container fee, the break points between import strategies are shifted markedly from the As-Is Scenario. For major importers, the break points in value and the corresponding optimal supply-chain strategy were found to be as summarized in Table 23.[29]

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[28] The low value of reduction for rail transit time variability relative to the reduction in dray transit time variability reflects the fact that most of the transit time variability for rail movement occurs outside the Los Angeles Basin.

[29] While only one of the figures given in Table S-2 differs from the figures in Table S-1 (i.e., $27 drops to $17), this change is very significant. As may be seen in Figure 8, a considerable portion of Asian imports

Table 23
Efficient Supply-Chain Strategies as a Function of Avg. Declared Value for Large Nation-Wide Importers – Congestion Relief Scenario

Value Range ($ per cu ft)	Strategy
0 – 13	Direct shipping using nearest port
13 – 17	Trans-load at multiple West Coast ports
17 and up	Trans-load only at LA – Long Beach

For importers lacking the scale and/or scope for transloading, the optimal supply-chain strategies were found to be as summarized in Table 24.

Table 24
Efficient Supply-Chain Strategies as a Function of Avg. Declared Value for Regional or Smaller-Scale Importers – Congestion Relief Scenario

Value Range ($ per cu ft)	Strategy
0 – 46	Direct shipping using nearest port
46 and up	Direct shipping using least-cost West Coast ports

As before, the analysis was repeated with the addition of a variable container fee assessed on all containers entering through the ports of Los Angeles and Long Beach. Fee values expressed in increments of $30 per 40-foot container ranging from $0 to $1,200 were tested. The direct and trans-load volumes via LA-Long Beach were then totaled for each fee value in order to construct curves of volume vs. container fee. Results are plotted in Figure 11. The red curve shows the total inbound container volume through the SPB Ports vs. fee value; the blue curve shows the trans-loaded inbound container volume vs. fee value. Also plotted in Figure 11 are the curves for the As-Is Scenario, the yellow curve showing the total inbound container volume and the brown curve showing the trans-loaded inbound volume.

As may be seen, congestion relief makes the LA – Long Beach ports more attractive. Even for a fee of $150, total SPB Ports inbound volume is higher than for a $0 fee in the As-Is Scenario. There is a "knee" in the total inbound volume curve for the fee equal to $210; at this point, the total volume is only 4.3% below the total volume in the As-Is Scenario with no fee. At this same point, the trans-load volume is 12.5% above the trans-load volume in the As-Is Scenario with no fee. The "knee" in the trans-loaded volume curve occurs for the fee equal to $240; even for a fee as high as $240, the trans-loaded

falls into the range of $17 - $27 per cubic foot in declared value. These imports are shifted from being candidates for trans-loading at multiple ports to candidates for trans-loading only at the SPB Ports.

volume is more than 12% greater than the trans-loaded volume in the As-Is Scenario with no fee.

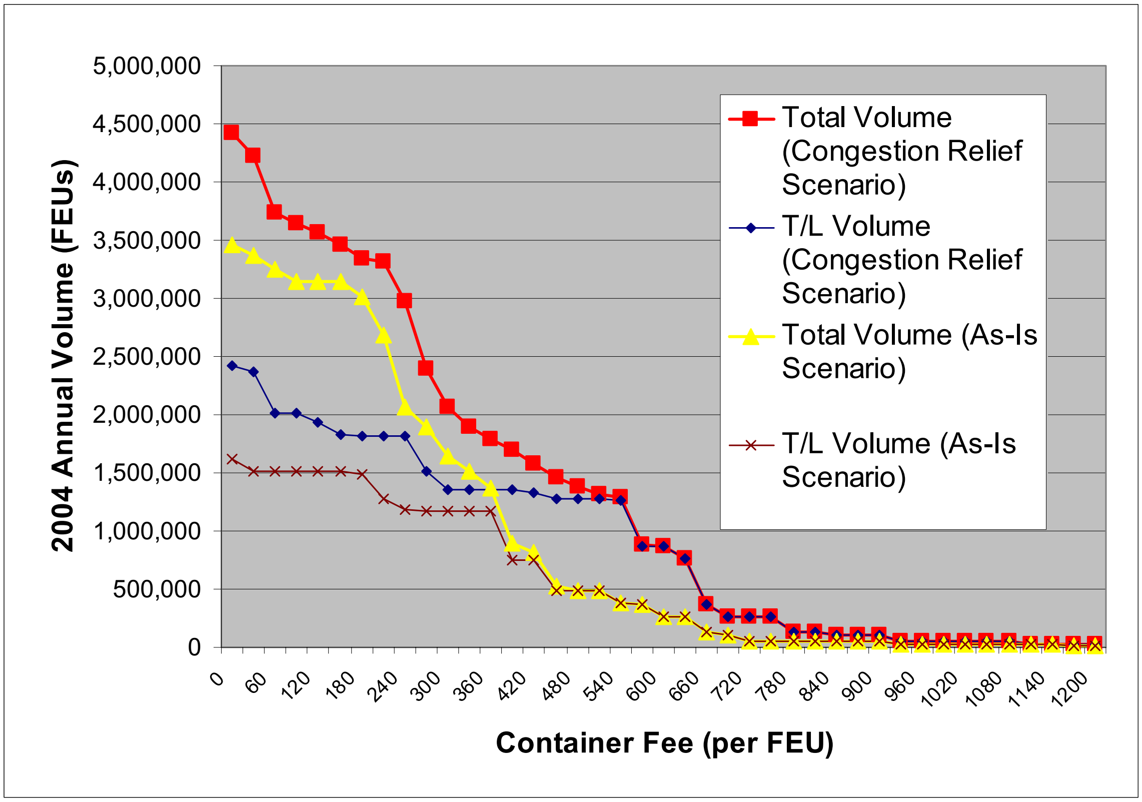

Figure 11.
Elasticity of Imports at the San Pedro Bay Ports – Congestion Relief Scenario

The economic impact of the Congestion Relief Scenario may be summarized as follows. The value of the reductions in transit time and transit time variability are more valuable to large, nationwide importers of moderate-valued and high-valued goods than $200 per FEU, and so total trans-loaded volume at the SPB Ports rises by 12.5%; but importers of low-valued goods and importers too small or too regional to effectively practice trans-loading find it more efficient to divert some of their imports to other ports, and so total import volume through the SPB Ports declines slightly. This structural change in the mix of traffic at the SPB Ports is significant. Direct shipments generate only dray, truck and rail employment within the Basin; trans-loaded shipments generate that employment plus additional dray employment plus deconsolidation center employment plus employment for value-added activities. Trans-loaded imports provide much more for the local economy compared to the imports that simply pass through the Region intact. The reductions in container transit times under the Congestion Relief Scenario would generate a significantly higher level of employment in Southern California, even if the reductions are funded by containers fees of $200 per FEU.

The current Alameda Corridor bonds have a 30-year life and an average interest rate of 5.6%. Assuming a 6% growth rate for imports and assuming a 6% interest rate and 30-year life for bonds, a $96 per TEU container fee ($192 per 40-foot container) assessed on all imported container loads at the SPB Ports would generate sufficient funds for about $20 billion in port access infrastructure improvements. The consultant is advised that dedicated truck lanes between the ports and the transloading warehouse district would cost about $17 billion; and another study completed by the author estimates main-line rail capacity improvements between Los Angeles and Barstow/Indio sufficient to accommodate 2025 traffic levels would cost about $3 billion dollars. This suggests that the Congestion Relief Scenario would be feasible and successful with a container fee (per forty-foot equivalent unit, i.e., per FEU) in the range of $190 - $200.

Model Limitations and Proper Interpretation of Results

As discussed in Chapter 7, there are important limitations to the Long-Run Elasticity Model. Most importantly, the model includes no capacity limitations in any channel or at any port. Transit time statistics are exogenously supplied to the model and are not updated if the Model shifts traffic between ports or modes. Limitations on available warehouse space for trans-loading activity are not considered.

The model results should be interpreted as indicating the points at which importers would experience an economic incentive to reduce import volumes through the SPB ports. Whether it is actually feasible in the short run for them to do so, considering capacity limitations, increased congestion at other ports, contract commitments, etc., is beyond the scope of the Long-Run Elasticity Model. Moreover, the Long-Run Model tacitly assumes capacity improvements will be made at other ports and in landside channels emanating form those ports so as to accommodate any projected diversions of traffic now handled via the SPB Ports.

Given a scenario in which there is economic incentive to shift imports between modes or between ports, there will be inertia inhibiting such shifts. Major shifts in import traffic may require considerable time to implement. Thus, in the short run, San Pedro Bay Ports traffic will be significantly more inelastic than the predictions of the Long-Run Model. However, given strong economic incentives for importers to shift traffic, one may expect *in the long run* that desired terminal and line haul capacities will get built, new port contracts will be negotiated, vessel strings will be adjusted, new trans-loading warehouses will be erected, and dray forces will be adjusted.

The Long-Run Elasticity Model is intended to inform public policy concerning potential major investments in access infrastructure for the San Pedro Bay Ports. Such infrastructure may require up to a decade to build, and financing instruments may require up to three decades to retire the principal. It seems very unwise to rely solely on estimations of short-run elasticity to justify such investments. Investment of large sums of public monies in long-term infrastructure should be confirmed to be sound on the basis of long-run elasticity calculations.

9. FUNDING POTENTIAL OF CONTAINER FEES

In Chapter 4 it was estimated that about 77% of the containers imported at the SPB Ports are loaded with goods that ultimately are consumed outside the local region. This suggests that container-fee-generated revenue would largely burden consumers living outside the SCAG Region. This fact does not detract from the logic of imposing a container fee, as infrastructure improvement in the SCAG Region facilitates nationwide access to low-cost Asian goods via the SPB Ports.

The SCAG Region does not receive adequate funding from traditional sources (the recently passed Federal Transportation Bill is a case in point) to mitigate the degradation of quality of life from heavy flows of imports consumed by the rest of the Country. That is why a new revenue source needs to be identified and used to mitigate SPB growth. Container fees are logical in this regard, and meet the test of cause and effect.

Level of Fees Required for Congestion Relief

In the Spring of 2004, the Alameda Corridor Transportation Authority (ACTA) retired the federal loan which made possible the bonding and sale of securities to construct the Alameda Corridor project. To do so, ACTA issued new bonds, some of which were tax exempt, while others were not (because of private sector benefits). The True Interest Rate (also known as Total Interest Cost, or "TIC") for the tax exempt portion of this re-financing was 5.6%. The bonds were sold as capital appreciation debt (zero-coupon) because current revenue is not sufficient to service this additional debt. The original financing terms of the federal loan was that it did not have to be repaid until all other debt was extinguished. The new financing entails bonds that are layered with differing maturities to account for the fact that revenue is building up and repayment is not immediate, nor are payments for the bond holder coupon.

The first ACTA debt repayment of the 2004 re-financing is due in 2006, and the final payment in 2033. The TIC includes interest rates of less than 3.5% up to more than 6 percent – depending on the length of maturity. The high relative interest rate for tax exempt financing is driven by the fact that ACTA revenue is not sufficient to pay interest on debt currently (and hence there is risk for the borrower) but cargo growth forecasts suggest future debt service coverage.

We suppose similar financing could be secured to fund proposed improvements to the access infrastructure for the SPB Ports. Such a program of future infrastructure improvements might include the following:

- Dedicated truck lanes on freeways from the SPB Ports to the trans-loading warehouse districts; potential price tag: $16 billion[30]

- 2025 program of improvements to main line rail capacity Los Angeles to Barstow and Indio; potential price tag: $3 billion[31]

- Other improvements, e.g., new or expanded rail and port terminals; potential price tag: $1 billion

An analysis of the impact on import market share of the SPB Ports from such improvements was carried out in Chapter 8 (Congestion Relief Scenario).

In 2004, inbound loaded containers at the SPB Ports totaled 6,928,400 TEUs. Let's assume six percent per year import growth over 30 years and 6% interest rate on tax-exempt bonds for infrastructure. While some of the funding may be secured from other sources, to be conservative let's further assume all of the $20 billion identified above must be financed by container fees. Then the required container fee collected over 30 years that generates a present value equal to $20 billion is calculated as

$$(\$20 \text{ Billion})/[(30)(6{,}928{,}400)] = \$96.22 \text{ per TEU}$$

or about $192 per 40-foot imported container.

If fees also were assessed on outbound loads and/or empties, this fee amount could be reduced accordingly.[32] However, the prospect of fees on outbound containers has serious drawbacks, as discussed in the next section.

From the analysis of the Congestion Relief Scenario in Chapter 8, we note that a fee of this size assessed only on imports is predicted to result in a relatively minor drop in total imports through the SPB Ports (3-4%) but a very attractive 12.5% increase in trans-load volume.

Our conclusion is that the Congestion Relief Scenario seems feasible and effective. A container fee of about $190 - $200 per imported FEU is large enough to fund the associated infrastructure improvements, and it results in an attractive traffic mix for the SPB Ports at a high overall volume level.

[30] An alternative under experimental investigation involves shuttle stack trains operating between rail ramps in the SPB Ports and ramps near the trans-loading warehouse districts.
[31] See *Final Report – Inland Empire Main Line Rail Study*, prepared for the Southern California Association of Governments by Leachman & Associates LLC, June 30, 2005.
[32] In 2004 outbound boxes accounted for 47% of total volume at the SPB Ports while inbound boxes accounted for 53%. Historically, inbound volume was significantly larger than outbound volume at the SPB Ports, but this has changed in recent years, with inbound and outbound volumes moving into balance (counting both loads and empties). The consultant believes the primary forces driving this balance are (1) the growth of trans-loading (which turns marine boxes in the LA Basin and therefore inhibits them from being returned at other ports), and (2) changes in rail pricing on WB movement of empty marine boxes, prompted by the railroads' desire to reduce their re-positioning of double-stack equipment.

Another factor to consider is whether an SPB container fee would be replicated elsewhere on the West Coast or U.S. We note that all U.S. ports are behind the investment curve to mitigate congestion. Thus, it is most likely that all U.S ports will follow the lead of the SCAG Region in embarking on infrastructure improvement programs funded by container fees.

The elasticity/diversion estimates of Chapter 8 are conservative in the sense that they assume the current transit times via the other ports prevail and with no container fees imposed at the other ports. Even in this situation, with the SPB Ports charging a $200 fee to retire the bonds on a wise and ambitious infrastructure program, the SPB traffic mix and overall traffic level would be very attractive. There is thus considerable reason to be sanguine for this alternative.

Fee Domain

In this section, we discuss whether the fee should be uniformly applied to all containers whether loaded or empty, import or export, vs. a fee applied solely to import loaded containers. We begin by noting that the Alameda Corridor Fee is applied to all rail-borne marine containers, whether loaded or empty, inbound or outbound. However, an empty container is assigned a fee that is about 25% as large as that for a loaded one. One could posit this form of structure for a new container fee or even make the fee uniform, on the grounds that a container whether loaded or empty absorbs the same infrastructure. Also relevant to the issue of fee domain is the fact that if a container is unloaded in the local SPB region, the empty is not going to be drayed to another West Coast port, solely to avoid a container charge as the transportation cost would be greater than the fee.

The problems with assigning fees to boxes other than inbound loads are twofold. First, for outbound loads, the average value per cubic foot of exports is very low, e.g., corrugated scrap, scrap metal, grain. Transit time is of little importance; transportation cost is the paramount consideration. A significant fee assessed on such exports is likely to cause substantial diversion to other ports of exports originating at inland points and possibly even curtailment of the exports themselves. Second, for outbound empties, a significant additional cost borne at the SPB Ports is likely to drive to other ports the return of containers made empty at inland points not in the SPB region. The resulting imbalance would entail a hardship on the railroads, requiring them to increase re-positioning movements of well cars for hauling double stacks. In all likelihood, the railroads would be impelled to add their own surcharges to the empty return of containers to other West Coast ports in an effort to correct this imbalance. Low-value exports via other West Coast ports might be curtailed.

The safest approach to the issue of container fee domain would seem to be to restrict the imposition of a fee to imports only. Further, we recommend that container charges be used rather than TEU fees. This approach compensates for the fact that all containers, regardless of size, consume infrastructure approximately equally.

10. RECOMMENDED POINT FOR FEE APPLICATION

In this chapter, the report will focus on the point along the supply chain where a container fee could be collected. The discussion will include the practicality of organizing support for a certain collection point including the political and institutional issues.

Potential points for fee collection could include any of the following who "touch" the container along the supply chain.

Potential point of collection	Comments
• Foreign or domestic manufacturer	Impossible to organize/no legal jurisdiction
• Foreign port or stevedoring company	No legal jurisdiction
• Steamship company	Possible if tied to use of U.S. Ports
• U.S. Ports	Excellent point of collection
• U.S. Customs	Best point of collection for ease of process
• U.S. stevedoring company	Good point of collection
• U.S. Customs Broker	Good if part of U.S Customs
• Truck drayage company	Politically untenable
• Railroads	No public control/ICC issues
• Beneficial owner of cargo	Impossible to organize voluntarily
• U.S. consumer	Non-starter politically (i.e., new tax)
• Infrastructure User Fees (Toll booths)	Operated world-wide (templates are many)

Fees are ideally collected at the wharf in the port of entry. This business model will ensure that all inbound loaded containers draw a fee and no transportation mode is exempted. In this way, the competitive place of all transportation providers will remain indifferent to the fee. Moreover, the revenue collected for a given fee value is maximized. Potential agencies executing the collection of the fees at the wharf include the ports themselves, U.S. Customs, or the stevedoring company.

Attempting to collect fees further down the supply chain entails all the risks of missed revenue plus undesired diversion from one transportation mode to another.

A related issue concerns what agency will be created to administer the fee and the infrastructure program, and how will that agency come into being. We turn to that issue next.

Voluntary Contract

The Alameda Corridor Agreement was a voluntary accord between three railroads and two ports. The financing plan was made easy by the fact that there is no risk of a new railroad entering the Southern California market. Thus, there was no risk that a non-signatory party would have a cost advantage over those who voluntarily agreed to pay a fee to build the project.[33]

Even in the case of Alameda Corridor, the catalyst for railroad participation was the cash they received from the public for the sale of their corridors. Without that component, there would have been little if any private sector financing for the project. The ports might have been forced to collect project fees at the dock. Without construction of the Alameda Corridor, port growth may have been stopped long ago. In the sense that the project mitigated landside train-related blockage of at-grade street crossings, it removed a potential environmental lawsuit aimed at blocking port growth. And the reality is that port tenants and shippers benefited because the ports were able to grow and Pacific Rim Countries increased their access to U.S. markets via the San Pedro Bay Ports.

In contrast to the Alameda Corridor, many of the voluntary point-of-collection alternatives for future container fees potentially involve risk of competitive disadvantage. For example, if all the truck draymen voluntarily agreed to pay a fee, new entries to the trucking industry would have an advantage as they have not agreed to pay such a fee. In contrast, if forced to pay by virtue of a tolling mechanism situated on a public highway voluntary participation is irrelevant to the cost and new trucking operations would pay the toll as would existing operators.

Given the fragmented nature of international trade where there are thousands of suppliers and hundreds of importers, we conclude that outright voluntary fee payments are unrealistic and that directed participation will be required. While it is wise and perhaps crucial to pursue widespread agreement and support among the ports, terminal operators, carriers and importers for an infrastructure program that reduces container transit times and is funded by container fees, as a practical matter the fees would need to be imposed on all imported containers, not just on those imported by parties signing some agreement to pay the fee.

Directed Fee Payments

Those along the supply chain who are capable of directing the payment of fees on waterborne containers are limited to U.S. Customs, the State of California and the Ports. Enabling legislation would be required.

In addition to legislation, the referendum approach could be considered, where the result (if passed) could be a requirement that the state or region's ports collect a container fee retiring bonds for infrastructure investment accommodating port growth and mitigate congestion and environmental harm. A state-wide referendum could be structured to include all ports in California (as could state or federal legislation). This action, if

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[33] Compare that situation with one where there is unlimited entry to the market place by truckers where competitive risk would be a key concern of anyone volunteering to pay a fee.

passed, would eliminate the risk of diversion that a fee may bring between California Ports.

If the ports or U.S. Customs collect the container fee, revenue for the entire universe of imports would be assured including the rail segment of traffic loaded at the docks. At the present time, it is estimated that only 21% of all inbound containers are loaded for rail movement on the dock at the SPB Ports, so capturing revenue on all port container traffic is important.

Based on the failure of previous efforts seeking new legislation at the federal level to increase U.S. Customs fees for use in mitigating port caused congestion, it seems unrealistic to think that the U.S. Congress will accomplish an about-face. At the state level, there are proposed bills to force the ports to collect a container fee. One of the arguments made by the maritime industry and business organizations against such fees is the potential for diversion. Until this study, there has been no analytical basis for assessing this potential.

It may be that state legislation requiring the state's ports to collect a container fee to build needed infrastructure is out of the question as well. However, the legislature might be willing to place a referendum on the ballot and thereby set up a mechanism for a direct citizen vote on the matter. We believe it is important that the SCAG Region develop a comprehensive and specific project list of infrastructure improvements to be funded by the container fee. The matter should be structured as a proposed infrastructure investment with specific goals for reductions in container transit times and variability in transit times to be achieved by implementation of a specific list of projects. In that way, stakeholders can weigh the unambiguous benefits of the proposed investment vs. the cost.

Current Status

Thus far, there is no comprehensive plan at any level of government to legislate the placement of a fee on waterborne containers that supports investment in a specific and comprehensive list of goods movement projects. And, thus far, the San Pedro Bay Ports have not supported the notion that they would be willing to collect such a fee. This means that the Region must resort to an innovative strategy to generate revenue for the mitigation of congestion caused by port traffic.

Recommendations

We recommend that (1) a complete and comprehensive list of infrastructure projects be formulated to determine construction cost, (2) that the financing cost and term be calculated for these intended investments (3) should other (direct) funding be unavailable or inadequate to fully cover cost, that a container fee exclusively used for retiring the bonds for said improvements be uniformly imposed on all imported containers, and (4) the practical point of collection is at the dock to be paid by the importer.

We believe that the importer is the appropriate party to pay for several reasons. (1) They are the primary beneficiary of the service. (2) The importers are the drivers of the US economy and are a much more potent political force for obtaining direct funding (thereby reducing the amount of the fee required for a given program of infrastructure improvement or alternatively enabling a greater program of improvement for a given fee amount) from Congress than either the port or maritime sectors. (3) Market forces would probably result in differentiated pricing over the different port gateways reflecting a more realistic view of operating and asset opportunity costs.

Specific recommendations are as follows:

- A new project investment list be developed whose elements can be demonstrated as directly (in whole or part) related to port traffic generation. This list is to be identified in the Southern California Associated Government's ("SCAG") Regional Transportation Plan ("RTP") Update. The project list would not include all the region's RTP projects, but be a subset thereof.

- For each RTP project mitigating port-caused congestion, there is a calculation made of the percentage of new container fee money to be used to finance the project relative to the total cost of the project.

- The California State Legislature pass enabling legislation allowing the ports to assess container fees at the wharf for investments in the RTP project list, or a statewide or regional referendum be initiated to activate the RTP plan.

- A regional authority (newly created or existing) be authorized to issue bonds for the RTP project list and, as improvements are completed, initiate and collect container fees to retire the bonds.

- Special federal legislation, if required, should be sought to overcome "restraint of trade" challenges to the container fee.

- The RTP project list should be prioritized by a measuring system which keeps goods moving efficiently with consideration for development timelines, and greatest good to the region based on congestion mitigation and quality of life issues.

- There must be a firewall to insure container fee proceeds are directed ONLY to RTP-identified mitigation projects, serving to rein in the urge to use the money for projects not related to port-caused congestion.

- The RTP update in future years can include additional projects, but those projects would be precluded from acquiring a priority higher than the original project list of the 2007 RTP Update.

- The container fee should be responsive to market conditions or port growth projections, with mechanisms to adjust fees as required and consistent with an inflation index.

11. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

Conclusions

San Pedro Bay import volume is much more elastic with respect to congestion than with respect to container fees. Nevertheless, import volume is elastic with respect to container fees.

Without congestion relief, even a small container fee would drive some traffic away from the San Pedro Ports. The Elasticity Model predicts that a $60 per FEU fee on inbound loaded containers at the SPB Ports would cut both total import volume and total trans-loaded import volume at the SPB Ports by approximately 6%.

San Pedro Bay imports are relatively inelastic up to an import fee value of about $200 per FEU. A fee of about $190 - $200 per FEU that retires the bonds on a wise and ambitious program of congestion relief seems a safe and effective investment. Total port volume might decrease marginally, but total trans-loaded volume is predicted to increase by more than 12%, resulting in an economically more attractive traffic base.

Fee values greater than $200 per FEU will have serious negative consequences for the SPB Ports and the region, even if predicated upon congestion relief.

Recommendations for Further Study

Asia – U.S. containerized trade is a highly fragmented enterprise. Data collection for this study was a tremendous challenge. Neither governments nor carriers collect statistics on import cargo flows after the marine container is devanned. Many important parameters of the analysis had to be estimated by the consultant based on limited information or based on information of limited completeness or accuracy (e.g., PIERS).

The importers themselves are the only ones in possession of accurate values of many of the key parameters of the analysis: actual transportation charges paid, actual mean and standard deviation of transit times, actual import volumes by destination, actual declared value of imports, etc. A follow-on effort by the consultant featuring more time engaging with the importers, gaining insight into their practices and gaining access to their data, would be extremely fruitful for improving the accuracy of the analysis.

The impact of changing congestion levels in alternative channels and at alternative ports is exogenous to the Elasticity Model at present, but it could become part of the model through the incorporation of formulas developed from queuing theory. Time and budget limitations prevented the consultant from doing this, but it could be done in a follow-on effort.

Finally, the Elasticity Model at present is quite labor-intensive. About a man-day is required per scenario at present to execute and record Model calculations. The consultant could make this much more automated and much less time-consuming in a follow-on effort.

APPENDICES.

Safety Stock Formulas for the General Case of Lead Times and Volumes Varying by Region

The general case is where there are multiple North American ports of entry and multiple regional distribution center (RDC) destinations. The different combinations have different lead times. Moreover, the volumes at the various RDCs are not necessarily equal. We add the index *n* for RDC and the index *m* for POE. The parameters are generalized as follows:

D - nation-wide average sales volume per week (in physical units, not dollars).
$MAPE$ – mean absolute percentage error (expressed as a fraction of one) in one-week-ahead forecasts of nation-wide sales.
D_n = amount of sales distributed from RDC *n*. We assume $\sum_n D_n = D$ and the proportion of nation-wide sales handled by each RDC is fixed.
D_{mn} = amount of imports en route to RDC *n* that are passed through port *m*. We assume $\sum_m D_{mn} = D_n$.
R – time between replenishment orders (from Asian suppliers). R is assumed to be 1 week for all importers.
L_{AO} – mean lead time (expressed in weeks) from when order is placed until port of entry for shipment is selected.
$L_{AW}(m)$ – mean lead time (expressed in weeks) for a shipment from point of origin to port of entry *m*, measured from when port of entry for shipment is selected until RDC is selected for land transport from POE *m*.
$L_W(m)$ – mean lead time (expressed in weeks) from departure from point of origin until RDC is selected for land transport from POE *m*.
$L_{NA}(m,n)$ – mean lead time (expressed in weeks) from when RDC *n* is selected for land transport from POE *m* until processed through the RDC *n*.
$\sigma_{L_{AW}}(m)$ – standard deviation of $L_{AW}(m)$.
$\sigma_{L_{NA}}(m,n)$ – standard deviation of $L_{NA}(m,n)$.
k – safety factor determining the level of safety stocks at RDCs. (Choosing $k = 2$ implies approximately a 98% probability of no stock-out.)

Formula for Pipeline Stock

The total in-transit inventory is expressed as

$$\sum_{m,n} \left(L_W(m) + L_{NA}(m,n) \right) D_{mn} \,. \tag{4}$$

Expression (4) is the generalization of expression (1).

Formulas for Safety Stock

In the direct shipping case, the total nation-wide safety stock is expressed as

$$(k)\left[\begin{array}{l} L_{AO}(1.25)^2(MAPE)^2D^2 \\ +\left(\sum_n\left(\dfrac{\sum_m D_{m,n}\sqrt{L_{AW}(m)+L_{NA}(m,n)+R}}{D_n}\right)\sqrt{\dfrac{D_n}{D}}(1.25)(MAPE)D\right)^2 \\ +\left(\sum_{m,n}D_{m,n}\sqrt{\sigma^2_{L_{AW}}(m)+\sigma^2_{L_{NA}}(m,n)}\right)^2 \end{array}\right]^{1/2} \qquad (5)$$

Expression (5) is the generalization replacing expression (2).

In the de-consolidation case, the total nation-wide safety stock is expressed as

$$(k)\left[\begin{array}{l} L_{AO}(1.25)^2(MAPE)^2D^2 \\ +\left(\sum_m\sqrt{\sum_n\left(\dfrac{D_{m,n}L_{AW}(m)}{D_n}\right)\left(\dfrac{D_n}{D}\right)(1.25)^2(MAPE)^2D^2}\right)^2 \\ +\left(\sum_n\left(\dfrac{\sum_m D_{m,n}\sqrt{L_{NA}(m,n)+R}}{D_n}\right)\sqrt{\dfrac{D_n}{D}}(1.25)(MAPE)D\right)^2 \\ +\left(\sum_{m,n}D_{m,n}\sqrt{\dfrac{\sum_m D_{m,n}}{\sum_n D_{m,n}}\sigma^2_{L_{AW}}(m)+\sigma^2_{L_{NA}}(m,n)}\right)^2 \end{array}\right]^{1/2} \qquad (6)$$

Expression (6) is the generalization replacing expression (3).